Quality Control Issues for the Roads of RHD; Present State, Challenges and Scope of Improvement

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DECLARATION

It is hereby declared that this dissertation or any part of it has not been submitted elsewhere for the award of any degree or diploma.

May, 2015

A. K. M. Shamsuzzoha

CERTIFICATE

This is my pleasure to certify that the dissertation entitled "Quality Control Issues for the Roads of RHD; Present State, Challenges and Scope of Improvement" is the original work of A. K. M. Shamsuzzoha and it is completed under my direct guidance and supervision. So far I know, the dissertation is an individual achievement of the candidate's own efforts, and it is not a conjoint work. I also certify that I have gone through the draft and final version of the dissertation and found it satisfactory for submission to the BRAC Institute of Governance and Development, BRAC University in partial fulfillment of the requirements for the degree of Masters in Procurement and Supply Management.

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ABSTRACT

Quality control is a prime performance issue for any organization. The Roads and Highways Department, RHD Bangladesh is facing problems with quality. The citizens of the country are not satisfied with the current road network of the country. But RHD have quality Assurance plan and the road network is constructed following it. Despite following the standards RHD is having quality problems. It is seen that quality problems are not mainly arising from construction but from the lack of proper support activities like management, human resource development, planning, value adding procurement and audit/review. It is rather a total quality issue. Total Quality Management is a new concept and widely used in private sector. The concept is not familiar in public sector but it is the solution that situation demands now in public sector. So the problems of RHD can be overcome by imparting Total Quality Management.

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INTRODUCTION

1.1 General

Quality is how well the design matches the original specifications. It is the ability of a product or service to satisfy stated or implied needs. It should be achieved by conforming to established requirements within an organization. From Roads & Highways Department, RHD perspective quality is to construct sustainable, serviceable and safe national highway, regional highway and zila road for the road users. Quality in road construction and maintenance can be incorporated in any phase of the procurement cycle for road construction using public money. Quality issues in road construction starts from the defining the need extends to design, sourcing, construction, contract management and maintenance.

1.2 Background and Rationale

If a simple question is asked “Are the road users satisfied with the quality of roads of RHD?” the answers gives idea about low satisfaction level of the road users. so it is necessary to find out the reasons behind such low satisfaction. Every organization has its own quality management system. A quality management system is a management technique used to communicate to employees what is required to produce the desired quality of products and services and to influence employee actions to complete tasks according to the quality specifications. RHD has sort and long term plans and managing system to impart quality in the road construction procurement and sourcing cycle. It is the base for quality road construction. It is necessary to find out these strategies and systems are up to the mark or not and find out the actual problem. The world now has moved towards “Total Quality Management” TQM philosophy to reduce waste and increase efficiency. So it is time for RHD to move towards TQM philosophy, imparting quality everywhere despite of its current quality assurance plan. For this reason the topic is selected.

1.3 Problem Statement

The Thesis title is,

"Quality Control Issues for the Roads of RHD; Present State, Challenges and Scope of Improvement."

For the analysis of the problem followings questions is asked,

- What are the steps those adds value in road construction procurement and sourcing process?
- What is the present state of these steps?
- What is the strategic plan for quality control?
- Is current practice in RHD compatible with other international standards?
- What are the current quality related problems in the procurement process?
- What are the Ways to overcome these problems?
- Is it possible to impart TQM concept in road construction procurement and sourcing process?

1.4 Objectives and Scope

The research objective is to evaluate the present state and practice of the road construction procurement and sourcing process. Find out the current problem in the road construction procurement and sourcing process. Compare it with the standard procuring and sourcing process mainly the find the compatibility with the TQM philosophy. Finally find out the ways of improvement and resolve the current problems. The current "Quality Assurance Plan" and the current practice will be critically evaluated to find out the problems and scope of improvement. The scope of the study is of a great deal. If ways of improving the quality in the road construction procurement and sourcing process comes out of the research then it will give a better value for the public money.

1.5 Limitations

The limitation of the study is the time constrain, the time available to conduct the research is not enough. the Data used are the internal data of RHD of the government of Bangladesh and no other data source is available.

LITERATURE REVIEW

2.1 General

Past literature exactly about the selected topic is not available. Before going detail on the topic the available literatures related to quality. The evaluation and improvements of quality control is also discussed in this chapter. Idea about the latest quality control philosophy like Total Quality Management is also given here. At last an overview of Roads and Highways Department is given.

2.2 Quality

The definition of quality depends on the role of the people defining it. The difficulty in defining quality exists regardless of product, and this is true for both manufacturing and service organizations. Generally quality can be defined from many perspectives.

2.2.1 Definitions of Quality

Conformance to specifications, How well a product or service meets the targets and tolerances determined by its designers. For example, the dimensions of the layers of the road to be constructed, the strength of the layers, and alignment of the road is mentioned in the design the quality road is constructed conforming these points. Conformance to specification is directly measurable, though it may not be directly related to the user's idea of quality.

Fitness for use, A definition of quality it evaluates how well the product or service performs for its intended use. For example, a road constructed should be safe and comfortable for transporting passengers and goods. However, this is a user-based definition in that it is intended to meet the needs of a specific user group.

Value for price paid, Quality defined in terms of product or service usefulness for the price paid. This is the only definition that combines economics with consumer criteria; it assumes that the definition of quality is price sensitive. For example, if a well constructed road does not contribute to the economy of the country then it is just waste of public money.

Support services Quality defined in terms of the support provided after the product or service is purchased or finished. Quality does not apply only to the product or service itself; it also applies to the people, processes, and organizational environment associated with it. For example, the quality of RHD is judged not only by the quality of end product the road, but also by the efficiency and accuracy of processing works.

Psychological criteria, is a subjective definition that focuses on the judgmental evaluation of what constitutes product or service quality. Different factors contribute to the evaluation, such as the atmosphere of the environment or the perceived prestige of the product.

2.2.2 Quality in Procurement Process

Quality should be imparted in every step of the sourcing process, as the quality failure cost is much higher than the quality control cost. The procurement cycle is shown in figure 2-1.

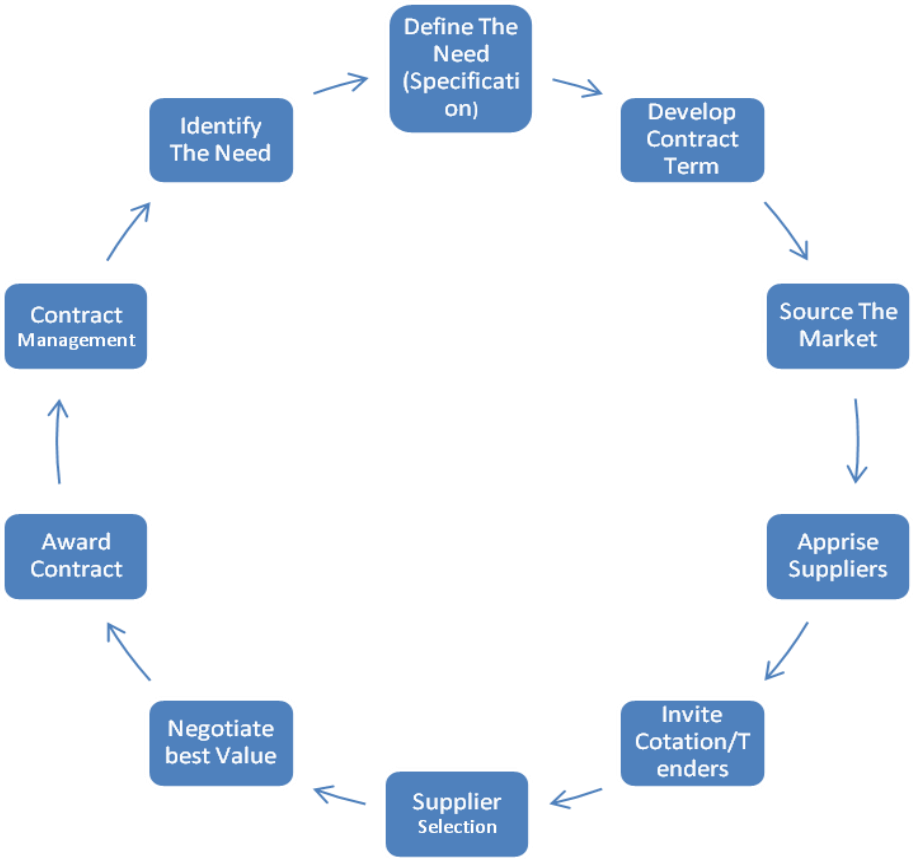

Figure 2-1: The Procurement Cycle

Quality can be incorporated in every step of the procurement process. Better quality service or product can be provided to the consumers/users if quality is taken into account in defining the need (planning), design, sourcing, supplier selection, project management or project review.

2.2.3 Cost of Quality

The reason quality has gained such prominence is that organizations have gained an understanding of the high cost of poor quality. Quality affects all aspects of the organization and has dramatic cost implications. The most obvious consequence occurs when poor quality creates dissatisfied customers/users and eventually leads to loss of reputation. However, quality has many other costs, which can be divided into two categories. The first category consists of costs necessary for achieving high quality, which are called *quality control costs*. These are of two types: *prevention costs* and *appraisal costs.* The second category consists of the cost consequences of poor quality, which are called *quality failure costs.* These include *external failure costs* and *internal failure costs*.

Prevention costs are all costs incurred in the process of preventing poor quality from occurring. They include quality planning costs, such as the costs of developing and implementing a quality plan. Also included are the costs of product and process design, from collecting customer information to designing processes that achieve conformance to specifications. Employee training in quality measurement is included as part of this cost, as well as the costs of maintaining records of information and data related to quality.

Appraisal costs are incurred in the process of uncovering defects. They include the cost of quality inspections, product testing, and performing audits to make sure that quality standards are being met. Also included in this category are the costs of worker time spent measuring quality and the cost of equipment used for quality appraisal.

Internal failure costs are associated with discovering poor product quality before the product reaches to the customers/users. One type of internal failure cost is *rework*, which is the cost of correcting the defective item. Sometimes the item is so defective that it cannot be corrected and must be thrown away. This is called *scrap,* and its costs include all the material, labor, and machine cost spent in producing the defective product. Other

types of internal failure costs include the cost of machine downtime due to failures in the process and the costs of discounting defective items for salvage value.

External failure costs are associated with quality problems that occur at the user site. These costs can be particularly damaging because customer faith and loyalty can be difficult to regain. They include everything from customer/user complaints, product returns, and repairs, to warranty claims, recalls, and even litigation costs resulting from product liability issues. A final component of this cost is lost sales and lost customers. External failure can sometimes put a company out of business almost overnight.

2.3 Quality Control

The old concept of quality control is to inspect for quality after production. In this old era the focus of quality control shifted from inspection to statistical sampling, then statistical sampling to organizational quality focus. After 1980s the quality control was totally customer driven. From that period and now on the organizations are imparting quality in every possible step of the process. Figure 2-2 shows the evaluation of quality control.

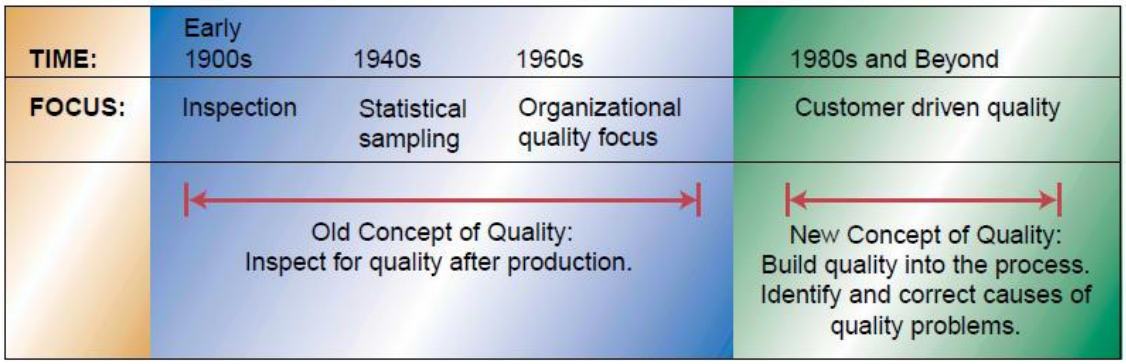

Figure 2-2: Evaluation of Quality Control.

2.3.1 Quality Assurance

Quality Assurance (QA) is a way of preventing mistakes or defects in manufactured products and avoiding problems when delivering solutions or services to customers. ISO 9000 defines quality assurance as "A part of quality management focused on providing confidence that quality requirements will be fulfilled". It thus differs subtly from quality control. QA is applied to physical products in pre-production to verify what will be made meets specifications and requirements, and during manufacturing production runs by

validating lot samples meet specified quality controls. Quality Assurance refers to administrative and procedural activities implemented in a quality system so that requirements and goals for a product, service or activity will be fulfilled. It is the systematic measurement, comparison with a standard, monitoring of processes and an associated feedback loop that confers error prevention. This can be contrasted with quality control, which is focused on process output. Two principles included in Quality Assurance are: "Fit for purpose", the product should be suitable for the intended purpose; and "Right first time", mistakes should be eliminated. QA includes management of the quality of raw materials, assemblies, products and components, services related to production, and management, production and inspection processes. Suitable quality is determined by product users, clients or customers, not by society in general. It is not related to cost, and adjectives or descriptors such as "high" and "poor" are not applicable. For example, a low priced product may be viewed as having high quality because it is disposable, where another may be viewed as having poor quality because it is not disposable.

2.3.2 Total Quality Management

In recent years, Total Quality Management (TQM) has received worldwide attention and is being adopted in many industries, particularly in developed economies. TQM has evolved primarily because of the changes in the global economy and also because of demand in market forces. Although control of quality has been practiced in many industries for several years, the adoption of TQM as a major preoccupation of businesses worldwide is very recent. The traditional control methods being implemented in industries to ensure quality have not yielded the results that were expected of them. Furthermore, rapidly changing technology and customer expectations have already affected organizations worldwide and thus have promoted the need for taking a new look at quality management. In this study we intend to discuss how TQM can be adopted in organizations that are replacing existing quality control systems to promote competition and growth. Various pioneering researchers have made significant contributions towards the design, development and application of the TQM system. These people are known as quality guru, their contribution is shown in table below,

Quality Guru	Main Contribution
Walter A. Shewhart	–Contributed to understanding of process variability. –Developed concept of statistical control charts.
W. Edwards Deming	–Stressed management's responsibility for quality. –Developed "14 Points" to guide companies in quality improvement.
Joseph M. Juran	–Defined quality as "fitness for use." –Developed concept of cost of quality.
Armand V. Feigenbaum	–Introduced concept of total quality control.
Philip B. Crosby	–Coined phrase "quality is free." –Introduced concept of zero defects.
Kaoru Ishikawa	–Developed cause-and-effect diagrams. –Identified concept of "internal customer."
Genichi Taguchi	–Focused on product design quality. –Developed Taguchi loss function.

Table 2-1: List of Various Quality Gurus.

2.3.3 Implementation of TQM

Implementing TQM is a major task. TQM, as stated earlier, is a major socio-technical system and an organization-wide intervention. As such, TQM must be approached in a systematic, pragmatic, well-thought-through fashion. Sink has suggested the following approach to the design, development and implementation of TQM:

- *Stage 0*: understanding the organizational system.
- *Stage 1*: developing a strategic plan for the TQM effort.
- *Stage 2*: planning assumptions.
- *Stage 3*: specifying strategic objectives.
- *Stage 4*: specifying tactical objectives.
- *Stage 5*: implementation planning.
- *Stage 6*: project management.
- *Stage 7*: measurement and evaluation.
- *Stage 8*: evaluation, accountability, and follow through, ensuring effective implementation.

According to Oakland, the task of implementing TQM can be daunting. The first decision is where to begin. This can be so difficult that many organizations never get started; this has been called TQP (Total Quality Paralysis). Oakland proposes 13 steps to TQM:

- Understanding of quality.
- Commitment to quality.
- Policy on quality.
- Organization for quality.
- Measurement cost of quality.
- Planning for quality.
- Design for quality.
- System for quality.
- Control of quality.
- Teamwork for quality.
- Capability for quality.
- Training for quality.
- Implementation of TQM.

Endosomwan and Savage-Moore propose a four-stage model to help organizations understand their TQM posture for the Malcolm Baldrige National Quality Award criteria and the TQM improvement process as:

- *Stage 1*: current organizational environment assessment.
- *Stage 2*: development of quality improvement strategy.
- *Stage 3*: assessment of education and training needs.
- *Stage 4*: implementation of quality strategy.

Burstein and Sedlack, find the major challenges to TQM implementation efforts in federal agencies:

- lack of comprehensive quality improvement education;
- uneven top management support;
- lack of customer orientation;
- lack of clarity in measurement systems;
- Scant resources for required investment.

As implementation of TQM is an important aspect, we feel that the organization must initially ask the following questions:

- What do we want from TQM?
- What are the implications for the organization?

The process of continuous improvement is plausible in an organization only if disturbances created due to interactions of the organization with different environments are identified and strategies are formulated to minimize these disturbances.

2.3.4 TQM in Developing Nations

The developing nations like Bangladesh are sometimes synonymous with poor quality products due to resource constrain. Some countries, which centuries ago were recognized as the best manufacturers of quality goods, are now producing shoddy products. This change has taken place because of severe constraints on their economies, lack of political will, lack of education and training and lack of commitment. Studies carried out indicate that the concepts of quality management are not understood by businesses. Often, quality is considered an optional extra. Unfortunately, many enterprises in the developing world have their production function isolated from the quality function. Most organizations in the developing world are suffering from the following:

- Lack of employee involvement and participation in quality improvement efforts.
- Lack of management commitment and motivation.
- Perception that quality is an optional extra and not a necessity for development.
- Traditional belief that “quality costs money”.
- Lack of communication and trust between suppliers, dealers, management and trade unions.
- Unorganized and indifferent customers.
- Lack of political support.
- Lack of established quality standards and inadequate test facilities.
- Obsolete technologies.
- Low level of education.
- Negligible capital investment in technologies, research and development and employees’ education, etc.

- Disrespect to the people so far as quality of life is concerned.
- Undesirable social tensions such as terrorism, violence, religious fundamentalism.

However, with increased competition, changes in global markets, changes in import-export policies and increased customer consciousness, some systematic efforts towards quality are taking place in some of the developing countries.

2.3.5 Quality Improvement

The plan–do–study–act (PDSA) cycle describes the activities an organization needs to perform in order to incorporate continuous improvement in its operation. This cycle is also referred to as the Shewhart cycle or the Deming wheel. The circular nature of this cycle shows that continuous improvement is a never-ending process. Let's look at the specific steps in the cycle.

Plan The first step in the PDSA cycle is to *plan*. Managers must evaluate the current process and make plans based on any problems they find. They need to document all current procedures, collect data, and identify problems. This information should then be studied and used to develop a plan for improvement as well as specific measures to evaluate performance.

Do The next step in the cycle is implementing the plan (*do*). During the implementation process managers should document all changes made and collect data for evaluation.

Study The third step is to *study* the data collected in the previous phase. The data are evaluated to see whether the plan is achieving the goals established in the *plan* phase.

Act The last phase of the cycle is to *act* on the basis of the results of the first three phases. The best way to accomplish this is to communicate the results to other members in the company and then implement the new procedure if it has been successful. Note that this is a cycle; the next step is to plan again. After we have acted, we need to continue evaluating the process, planning, and repeating the cycle again.

Benchmarking Another way organizations implement continuous improvement is by studying business practices of organizations considered "best in class." This is called benchmarking**.** The ability to learn and study how others do things is an important part of continuous improvement. The benchmark company does not have to be in the same

business, as long as it excels at something that the company doing the study wishes to emulate. For example, many companies have used Lands' End to benchmark catalog distribution and order filling, because Lands' End is considered a leader in this area. Similarly, many companies have used American Express to benchmark conflict resolution.

2.3.6 International Standards

International Standardization is the way of quality. To achieve the international standard organizations improve its overall procedures. When such standard is achieved to maintain it the organizations do their best. The best international standard for quality ISO 14000 is discussed below.

ISO 14000 Standards

The need for standardization of quality created an impetus for the development of other standards. In 1996 the International Standards Organization introduced standards for evaluating a company's environmental responsibility. These standards, termed **ISO 14000,** focus on three major areas:

Management systems standards measure systems development and integration of environmental responsibility into the overall business.

Operations standards include the measurement of consumption of natural resources and energy.

Environmental systems standards measure emissions, effluents, and other waste systems.

With greater interest in green manufacturing and more awareness of environmental concerns, ISO 14000 may become an important set of standards for promoting environmental responsibility.

2.4 Organizational Aspects of Quality

An organization consists of Hard aspects i.e. structure, strategy and system, on the other hand the organization have soft aspects i.e. shared values, style, skills and staff. in the

subsequent sub section the hard and soft aspects is discussed. Various types' organizational structure is discussed broadly as the all the hard aspects are taken into consideration designing the organizational structure. An organizational structure defines how activities such as task allocation, coordination and supervision are directed towards the achievement of organizational aims. An organization can be structured in many different ways, depending on their objectives. The structure of an organization will determine the modes in which it operates and performs. For better understanding of hard aspects strategy and some types of organizational structure those are familiar to RHD are discussed below

2.4.1 Strategy

Strategy is important because the resources available to achieve these goals are usually limited. Strategy generally involves setting goals, determining actions to achieve the goals, and mobilizing resources to execute the actions. A strategy describes how the ends (goals) will be achieved by the means (resources). The senior leadership of an organization is generally tasked with determining strategy. Strategy can be intended or can emerge as a pattern of activity as the organization adapts to its environment or competes. It involves activities such as strategic planning and strategic thinking. In developing countries like Bangladesh strategic GAP analysis is important.

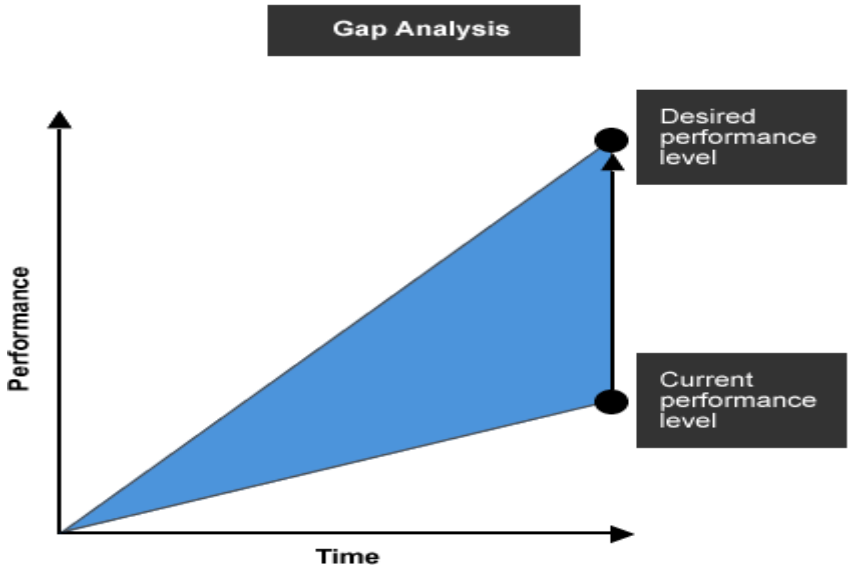

Figure 2-3: GAP Analysis

Gap analysis identifies gaps between the optimized allocation and integration of the inputs (resources), and the current allocation level. This reveals areas that can be improved. Gap analysis involves determining, documenting, and approving the difference between business requirements and current capabilities. Gap analysis naturally flows from benchmarking and other assessments. Once the general expectation of performance in the industry is understood, it is possible to compare that expectation with the company's current level of performance. This comparison becomes the gap analysis. Such analysis can be performed at the strategic or operational level of an organization. Figure below gives idea about GAP analysis.

2.4.2 Bureaucratic structures

Most of the government organizations have the bureaucratic structure. Weber gives the analogy that "the fully developed bureaucratic mechanism compares with other organizations exactly as does the machine compare with the non-mechanical modes of production. Precision, speed, unambiguity, strict subordination, reduction of friction and of material and personal costs- these are raised to the optimum point in the strictly bureaucratic administration." Bureaucratic structures have a certain degree of standardization. They are better suited for more complex or larger scale organizations, usually adopting a tall structure. The tension between bureaucratic structures and non-bureaucratic is echoed in Burns and Stalker's distinction between mechanistic and organic structures.

The Weberian characteristics of bureaucracy are:

- Clear defined roles and responsibilities
- A hierarchical structure
- Respect for merit

Bureaucratic Structures have many levels of management ranging from senior executives to regional managers, all the way to operation managers. Since there are many levels, decision-making authority has to pass through more layers than flatter organizations. Bureaucratic organization has rigid and tight procedures, policies and constraints. This

kind of structure is reluctant to adapt or change what they have been doing since the company started. Organizational charts exist for every department, and everyone understands who is in charge and what their responsibilities are for every situation. Decisions are made through an organized process, and a strict command and control structure is present at all times. In bureaucratic structures, the authority is at the top and information is then flowed from top to bottom. This causes for more rules and standards for the company which operational process is watched with close supervision. Some advantages for bureaucratic structures for top-level managers are they have a tremendous control over organizational structure decisions. This works best for managers who have a command and control style of managing. Strategic-decision making is also faster because there are fewer people it has to go through to approve. Some disadvantages in bureaucratic structures are it can discourage creativity and innovation in the organization. This can make it hard for a company to adapt to changing conditions in the marketplace.

2.4.3 Functional structure

A functional organizational structure is a structure that consists of activities such as coordination, supervision and task allocation. The organizational structure determines how the organization performs or operates. The term organizational structure refers to how the people in an organization are grouped and to whom they report. One traditional way of organizing people is by function. Some common functions within an organization include production, marketing, human resources, and accounting.

This organizing of specialization leads to operational efficiency where employees become specialists within their own realm of expertise. The most typical problem with a functional organizational structure is however that communication within the organization can be rather rigid, making the organization slow and inflexible. Therefore, lateral communication between functions becomes very important, so that information is disseminated, not only vertically, but also horizontally within the organization. Communication in organizations with functional organizational structures can be rigid because of the standardized ways of operation and the high degree of formalization.

As a whole, a functional organization is best suited as a producer of standardized goods and services at large volume and low cost. Coordination and specialization of tasks are centralized in a functional structure, which makes producing a limited amount of products or services efficient and predictable. Moreover, efficiencies can further be realized as functional organizations integrate their activities vertically so that products are sold and distributed quickly and at low cost.[11] For instance, a small business could make components used in production of its products instead of buying them.

Even though functional units often perform with a high level of efficiency, their level of cooperation with each other is sometimes compromised. Such groups may have difficulty working well with each other as they may be territorial and unwilling to cooperate. The occurrence of infighting among units may cause delays, reduced commitment due to competing interests, and wasted time, making projects fall behind schedule. This ultimately can bring down production levels overall, and the company-wide employee commitment toward meeting organizational goals.

2.4.4 Divisional structure

The Divisional structure or product structure is a configuration of an organization, which breaks down the company into divisions that are self-contained. A division is self-contained and consists of collections of functions which work to produce a product. It also utilizes a plan to compete and operate as a separate business or profit center. Employees, who are responsible for certain market services of types of products, are placed in divisional structure in order to increase their flexibility. The process can be further broken down into geographic, and product services for different consumers (for example companies or households). The divisions may also have their own departments such as marketing, sales, and engineering.

The advantage of divisional structure is that it uses delegated authority so the performance can be directly measured with each group. This results in managers performing better and high employee morale. Another advantage of using divisional structure is that it is more efficient in coordinating work between different divisions, and

there is more flexibility to respond when there is a change in the market. Also, an organization will have a simpler process if they need to change the size of the business by either adding or removing divisions. When divisional structure is utilized more specialization can occur within the groups. When using divisional structures that are organized by either markets or geographic areas they generally have similar function and are located in different regions. This allows business decisions and activities coordinated locally.

The disadvantages of the divisional structure are that it can support unhealthy rivalries among divisions. This type of structure may increase costs by requiring more qualified managers for each division. Also, there is usually an over-emphasis on divisional more than organizational goals which results in duplication of resources and efforts like staff services, facilities, and personnel.

2.4.5 Matrix structure

The matrix structure groups employees by both function and product. This structure can combine the best of both separate structures. A matrix organization frequently uses teams of employees to accomplish work, in order to take advantage of the strengths, as well as make up for the weaknesses, of functional and decentralized forms. There are both advantages and disadvantages of the matrix structure; some of the disadvantages are an increase in the complexity of the chain of command. This occurs because of the differentiation between functional managers and project managers, which can be confusing for employees to understand who is next in the chain of command. An additional disadvantage of the matrix structure is higher manager to worker ratio that results in conflicting loyalties of employees. However the matrix structure also has significant advantages that make it valuable for companies to use. The matrix structure improves upon the “silo” critique of functional management in that it diminishes the vertical structure of functional and creates a more horizontal structure which allows the spread of information across task boundaries to happen much quicker. Moreover matrix structure allows for specialization that can increase depth of knowledge & allows individuals to be chosen according to project needs. This correlation between individuals

and project needs is what produces the concept of maximizing strengths and minimizing weaknesses.

2.4.6 The Soft Aspects

The soft aspects are related to the Human Resource Management. Skills, Shared values, staff and styles are developed by the Human resource management of the an organization. This includes the job design, job description, recruitment process, training etc.

2.5 Quality Assessment Tools

Assessing the state of quality of the process, performance or anything of an organization is very important for applying quality control. There are many quality assessment tools available. The Project Management Institute references Seven Basic Tools in A Guide to the Project Management Body of Knowledge as an example of a set of general tools useful for planning or controlling project quality. The Seven Basic Tools of Quality is a designation given to a fixed set of graphical techniques identified as being most helpful in troubleshooting issues related to quality. They are called *basic* because they are suitable for people with little formal training in statistics and because they can be used to solve the vast majority of quality-related issues. The Seven Basic Tools stand in contrast to more advanced statistical methods such as survey sampling, acceptance sampling, statistical hypothesis testing, design of experiments, multivariate analysis, and various methods developed in the field of operations research. Some of the quality assessment tools will be used to evaluate the quality position of RHD, for this reason seven basic tools for quality are discussed in following sections.

2.5.1 Cause-and-Effect Diagrams

Cause-and-effect diagrams (also called Ishikawa diagrams, fishbone diagrams, herringbone diagrams or Fishikawa (Darko 2014)) are causal diagrams created by Kaoru Ishikawa (1968) that show the causes of a specific event. Ishikawa diagrams were popularized by Kaoru Ishikawa, who pioneered quality management processes in the Kawasaki shipyards, and in the process became one of the founding fathers of modern

management. Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation. The categories typically include:

- People: Anyone involved with the process
- Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
- Machines: Any equipment, computers, tools, etc. required to accomplish the job
- Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
- Measurements: Data generated from the process that are used to evaluate its quality
- Environment: The conditions, such as location, time, temperature, and culture in which the process operates

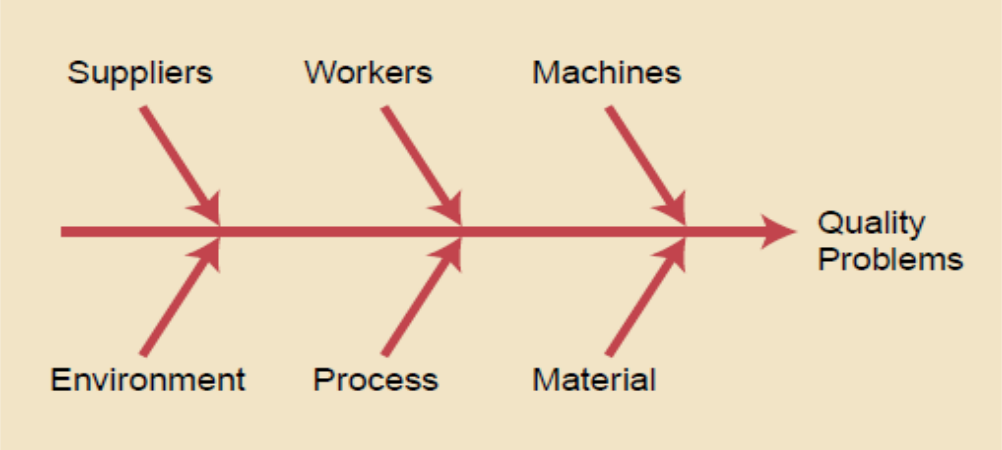

Figure 2-4: Sample Cause Effect Diagram

The basic concept was first used in the 1920s, and is considered one of the seven basic tools of quality control. It is known as a fishbone diagram because of its shape, similar to the side view of a fish skeleton. Causes in the diagram are often categorized, such as to the 6 M's, described below. Cause-and-effect diagrams can reveal key relationships among various variables, and the possible causes provide additional insight into process behavior.

- Machine (technology)
- Method (process)
- Material (Includes Raw Material, Consumables and Information.)
- Man Power (physical work)/Mind Power (brain work): Kaizens, Suggestions
- Measurement (Inspection)
- Milieu/Mother Nature (Environment)

The original 6Ms used by the Toyota Production System have been expanded by some to include the following and are referred to as the 8Ms. However, this is not globally recognized. It has been suggested to return to the roots of the tools and to keep the teaching simple while recognizing the original intent; most programs do not address the 8Ms.

- Management/Money Power
- Maintenance

Causes can be derived from brainstorming sessions. These groups can then be labeled as categories of the fishbone. They will typically be one of the traditional categories mentioned above but may be something unique to the application in a specific case.

2.5.2 Check Sheet

The check sheet is a form (document) used to collect data in real time at the location where the data is generated. The data it captures can be quantitative or qualitative. When the information is quantitative, the check sheet is sometimes called a tally sheet. The defining characteristic of a check sheet is that data are recorded by making marks ("checks") on it. A typical check sheet is divided into regions, and marks made in different regions have different significance. Data are read by observing the location and number of marks on the sheet.

Check sheets typically employ a heading that answers the Five Ws:

- Who filled out the check sheet

- What was collected (what each check represents, an identifying batch or lot number)
- Where the collection took place (facility, room, apparatus)
- When the collection took place (hour, shift, day of the week)
- Why the data were collected

2.5.3 Control Charts

Control charts, also known as Shewhart charts (after Walter A. Shewhart) or process-behavior charts, in statistical process control are tools used to determine if a manufacturing or business process is in a state of statistical control. The control chart is one of the seven basic tools of quality control. Typically control charts are used for time-series data, though they can be used for data that have logical comparability (i.e. you want to compare samples that were taken all at the same time, or the performance of different individuals), however the type of chart used to do this requires consideration.

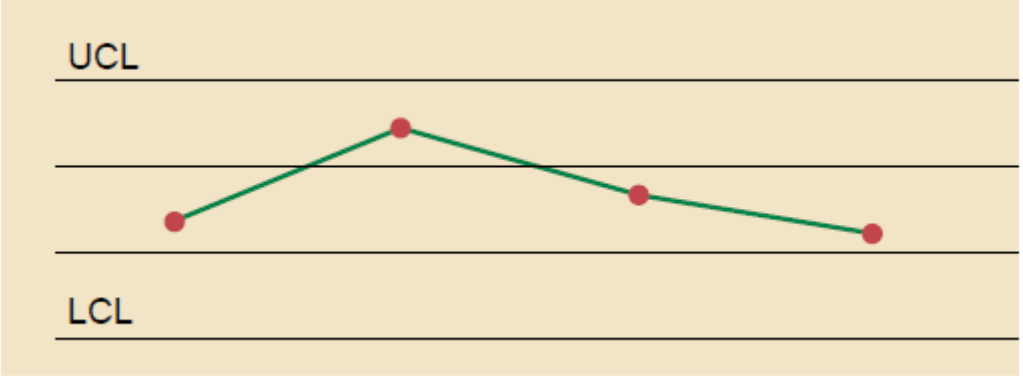

Figure 2-5: A Sample Control Chart

If analysis of the control chart indicates that the process is currently under control (i.e., is stable, with variation only coming from sources common to the process), then no corrections or changes to process control parameters are needed or desired. In addition, data from the process can be used to predict the future performance of the process. If the chart indicates that the monitored process is not in control, analysis of the chart can help determine the sources of variation, as this will result in degraded process performance. A process that is stable but operating outside of desired (specification) limits (e.g., scrap

rates may be in statistical control but above desired limits) needs to be improved through a deliberate effort to understand the causes of current performance and fundamentally improve the process.

2.5.4 Histograms

A histogram is a graphical representation of the distribution of data. It is an estimate of the probability distribution of a continuous variable (quantitative variable) and was first introduced by Karl Pearson. To construct a histogram, the first step is to "bin" the range of values -- that is, divide the entire range of values into a series of small intervals -- and then count how many values fall into each interval. A rectangle is drawn with height proportional to the count and width equals to the bin size, so that rectangles about each other. A histogram may also be normalized displaying relative frequencies. It then shows the proportion of cases that fall into each of several categories, with the sum of the heights equaling 1. The bins are usually specified as consecutive, non-overlapping intervals of a variable. The bins (intervals) must be adjacent and usually equal size. The rectangles of a histogram are drawn so that they touch each other to indicate that the original variable is continuous.

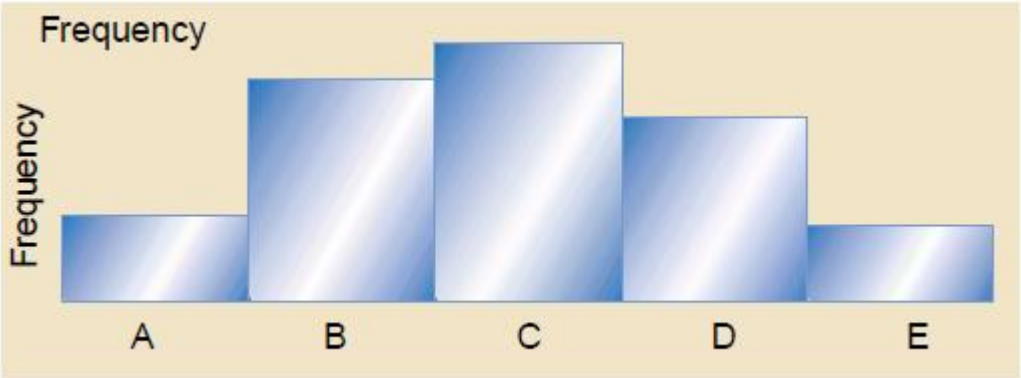

Figure 2-6: A Smple Histogram

A histogram can be thought of as a simplistic kernel density estimation, which uses a kernel to smooth frequencies over the bins. This yields a smoother probability density function, which will in general more accurately reflect distribution of the underlying variable. The density estimate could be plotted as an alternative to the histogram, and is

usually drawn as a curve rather than a set of boxes. Histograms are often confused with bar charts. A bar chart is a plot of categorical variables, and the discontinuity should be indicated by having gaps between the rectangles. Often this is neglected which may lead to a bar chart being confused for a histogram.

2.5.5 Pareto Chart

A Pareto chart, named after Vilfredo Pareto, is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative total is represented by the line. The left vertical axis is the frequency of occurrence, but it can alternatively represent cost or another important unit of measure. The right vertical axis is the cumulative percentage of the total number of occurrences, total cost, or total of the particular unit of measure. Because the reasons are in decreasing order, the cumulative function is a concave function. To take the example above, in order to lower the amount of late arrivals by 78%, it is sufficient to solve the first three issues. The purpose of the Pareto chart is to highlight the most important among a (typically large) set of factors. In quality control, it often represents the most common sources of defects, the highest occurring type of defect, or the most frequent reasons for customer complaints, and so on. Wilkinson (2006) devised an algorithm for producing statistically based acceptance limits (similar to confidence intervals) for each bar in the Pareto chart.

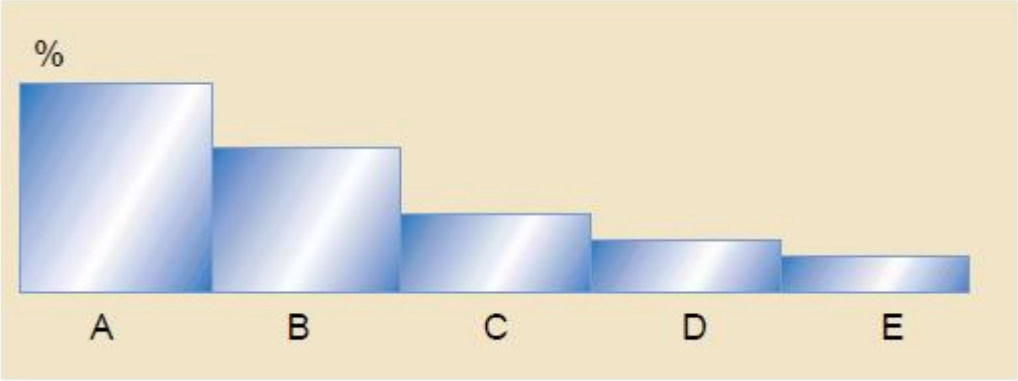

Figure 2-7: A Sample Pareto Chart

These charts can be generated by simple spreadsheet programs, such as OpenOffice.org Calc and Microsoft Excel and specialized statistical software tools as well as online quality charts generators.

2.5.6 Scatter Diagrams

Scatter diagrams are graphs that show how two variables are related to one another. They are particularly useful in detecting the amount of correlation, or the degree of linear relationship, between two variables. For example, increased production speed and number of defects could be correlated positively; as production speed increases, so does the number of defects. Two variables could also be correlated negatively, so that an increase in one of the variables is associated with a decrease in the other. For example, increased worker training might be associated with a decrease in the number of defects observed. The greater the degrees of correlation, the more linear are the observations in the scatter diagram. On the other hand, the more scattered the observations in the diagram, the less correlation exists between the variables. Of course, other types of relationships can also be observed on a scatter diagram, such as an inverted U. This may be the case when one is observing the relationship between two variables such as oven temperature and number of defects, since temperatures below and above the ideal could lead to defects.

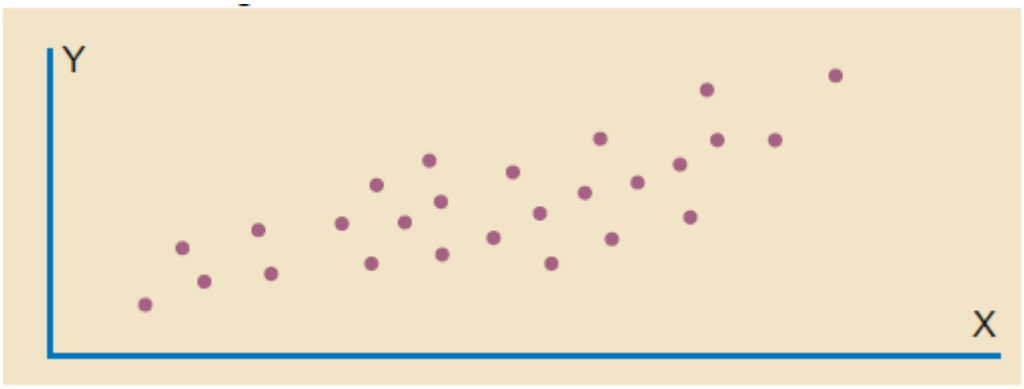

Figure 2-8: A Sample Scatter Diagram

2.5.7 Flowcharts

A flowchart is a schematic diagram of the sequence of steps involved in an operation or process. It provides a visual tool that is easy to use and understand. By seeing the steps involved in an operation or process, everyone develops a clear picture of how the operation works and where problems could arise.

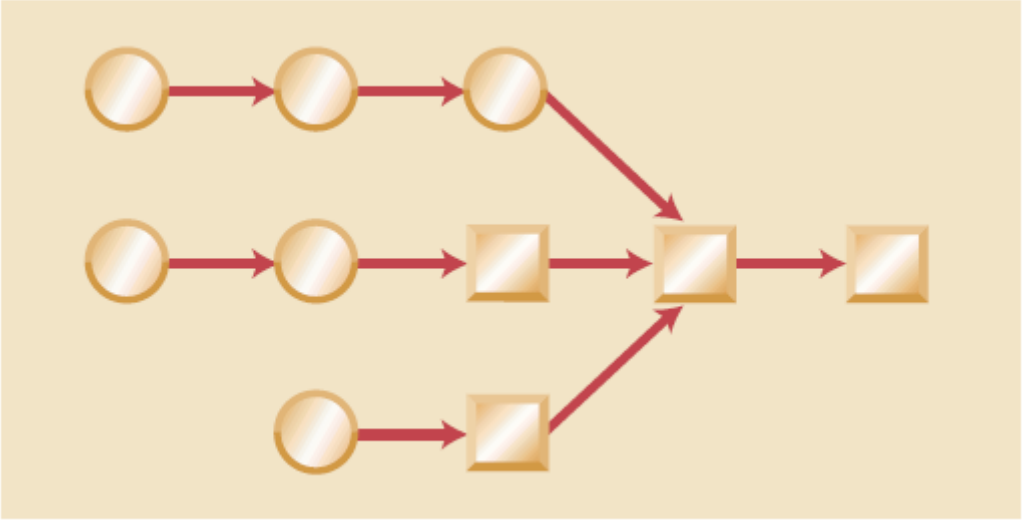

Figure 2-9: A Sample Flow Chart

2.6 Overview of RHD

The Roads and Highways Department (RHD) was created in 1962 when the old 'Construction & Building (C&B) organization was split into 2 separate bodies (the other being Public Works Department). RHD is responsible for the construction and the maintenance of the major road and bridge network of Bangladesh. Since the Department was established the size of the major road network in Bangladesh has grown from 2,500 kms to the present network of 21,589.65 The RHD is headed by a Chief Engineer who is supported by a number of Additional Chief Engineers. The total number of posts in the Department is 9,369. RHD is responsible for construction and maintenance of the major road network of Bangladesh. The mission of RHD is **"To provide a safe, cost effective & well maintained road network."**

2.6.1 RHD Road Network

The Roads and Highways Department (RHD) in Bangladesh is responsible for over 21,000 km of roads which are classified in Table 3-1. Not all the roads, particularly in the Zila category, are yet paved. As Table 2-2 shows, 9,719 km of the total Zila roads are paved, or just under 72% of the total. Map 3.1 shows the current RHD network.

Road Class)	**Definition**	**Length (km)**
National Highways	Highways connecting National capital with Divisional HQ's or sea ports or land ports or Asian Highway.	3,570
Regional Highways	Highways connecting District HQ's or main river or land ports or with each other not connected by National Highways.	4,323
Zila Roads	Roads connecting Districfft HQ's with Upazilla HQ's or connecting one Upazilla HQ to another Upazilla HQ by a single main connection with National/Regional Highway, through shortest distance/route.	13,678
Total		**21,571**

Table 3-2: Roads and Highways road network definition and lengths (Bangladesh Gazette, 6 November 2003 and Planning Commission, 2007)

RHD also construct and maintain bridges of length less than 1.6 km on its roads. The information of bridges is given below.

No. of structures by type	
Box Culvert	9441
Slab Culvert	3991
RCC Girder Bridge	2387
PC Girder Bridge	405
RCC Bridge	244
Arch Masonry	318
Truss with RCC Slab	30
Truss with Steel Deck	204
Truss With Timber Deck	6
Baily with Steel Deck	973
Baily with Timber Deck	23
Steel Beam & RCC Slab	230
PC Box	5


Map 2.1: RHD Road Network
N
W
E
S
International Boundary
RHD Zone Boundary
National Highway
Regional Highway
Zila Road
District HQ
Panchagarh
Thakurgaon
Nilphamari
Lalmonirhat
Rangpur
Kurigram
Dinajpur
Gaibandha
Joypurhat
Sherpur
Sunamganj
Sylhet
Naogaon
Bogra
Jamalpur
Netrakona
Mymensingh
Nawabganj
Rajshahi
Natore
Sirajganj
Kishoreganj
Habiganj
Moulvibazar
Tangail
Pabna
Gazipur
Brahmanbaria
Manikganj
Narsingdi
Meherpur
Kushtia
Rajbari
Dhaka
Chuadanga
Faridpur
Narayanganj
Jhenaidah
Comilla
Magura
Munshiganj
Chandpur
Narail
Sariatpur
Khagrachhari
Jessore
Gopalganj
Madaripur
Lakshmipur
Feni
Khulna
Noakhali
Satkhira
Barisal
Rangamati
Bagerhat
Bhola
Pirojpur
Chittagong
Patuakhali
Bandarban
Barguna
Cox's Bazar
Bay of Bengal
Data Sources:
1. RHD Road-Centerline GPS Survey 2002- 04
Road Information from RHD Field Divisions
based on the latest Road Reclassification by
the Planning Commission of Bangladesh
2. River Layer from FAP-19 of WARPO, 1996
3. International Boundary Layer from FAP-19 of
WARPO, 1995
4. Head Quarters Layer from LGED Thana
Base Map, 1992
5. RHD Ferry Layer from RHD LRP Data, 2004
6. Railway Layer from FAP-19 of WARPO, 1992
Datum: Everest 1830
Projection: Lamberty Conformal Conic(LCC) System
25 12.5 0 25 50 75 100
Kilometers

Figure 2-10: RHD Road Network

2.6.2 Activities of RHD

RHD is responsible for the construction and maintenance of 21,571 km of its road network. The works for maintenance and rehabilitation is given in table below,

Routine Maintenance:	Off-pavement works: .	Includes all regular works along a road such as maintaining shoulders, roadside vegetation control, cleaning side drains and pipe culverts, maintenance of signs and signals.
	Patching	Repair of potholes based on a standard pothole unit of 0.01m3 per pothole. The quantity of pothole repairing shall not be more than 1% of the total surface.
	Crack Sealing	Sealing to cracks using Seal Coat/Fog Seal. It assumes a maximum in any one kilo meter of 5% area affected.
Periodic Maintenance:	Preparatory Patching	Patching potholes and regulating surface irregularities prior to undertaking the treatments like DBST or DBS Overlay. Should not be more than 2% of the total quantity of overlay for National roads and maximum of 5% for Regional roads.
	Preparatory Edge Repair	Allows for restoring pavement edges that have been damaged by vehicles leaving the road to drive onto the shoulder prior to undertaking the treatments like DBST or DBS Overlay.
	DBST	Applying two layers of surface treatments on the prepared road surface. The total thickness has been specified as 25mm. This is applied in medium to highly trafficked road. Life expectancy assumed to be 3 years.
	Bituminous Carpeting	This is a 40 mm thick manual overlay used in low trafficked roads in place of dense bituminous overlay. Life expectancy has been taken as 2 to 4 years.
	Overlay	Machine laid premixed dense bituminous surfacing overlay 50 – 80 mm thick used in medium to highly trafficked roads. Carefully controlled overlay may be applied in response to badly damaged road surface or high roughness so as to obtain a predefined roughness

		level (2.5 to 3 IRI). Life expectancy assumed to be 5 years.
Rehabilitation	Partial Reconstruction	Reconstruction of the upper pavement layers following scarification of the existing damaged surface and re-compaction. Normally a 150-200 mm crushed aggregate base with a dense bituminous surfacing of between 75 and 195mm, depending on traffic level. This is a treatment to overcome higher roughness or higher levels of surface cracking resulting from delayed maintenance. Life expectancy should be 10 years prior to major periodic maintenance. Full design of the pavement must be undertaken prior to treatment. Shoulder rehabilitation would also be provided where necessary.
	Complete Reconstruction	A major reconstruction on the existing alignment and within the same overall dimension limits. The road is not widened. The pavement must be fully designed prior to construction and shoulder rehabilitation provided where necessary. Life expectancy should be 10 years before major periodic maintenance. Applied where there are extremely high levels of roughness and extensive cracking.
Holding Treatment		DBST triggered when rehabilitation is required but budget constraints do not permit the preferred treatment. Expected to last for 3 years

Table 3-3: Maintenance and Rehabilitation Works of RHD

New road construction includes the sequential construction of the various layers of the road. The layers are the sub grade (soil), improved sub grade (compacted sand), sub base (aggregate, sand), base (aggregate/stone, sand), surface course (asphalt concrete).

PRESENT STATE OF QUALITY CONTROL IN RHD

3.1 General

Present state of quality control in RHD is discussed in this chapter. Chapter includes sections like organizational supports for quality, strategies for quality, quality in sourcing, quality in construction management and at last audit. Present state of each of these points is evaluated in the following sections to find out the present of quality control.

3.2 Organizational Support for Quality Control

RHD is a government organization under the Road Transport and Highways Division, RTHD of the Ministry of Road Transport and Bridges. Being a government organization the processes of the organization is bureaucratic in nature. For any approval or order of the government bureaucratic process is followed. RHD is headed by the Chief Engineer; he is the Chief Executive Officer of the organization. RHD is divided into 10 operational zones and five wings, which are headed by Additional Chief Engineers ACEs. The operational zones in the field are Dhaka, Chittagong, Comilla, Sylhet, Rajshahi, Rangpur, Khulna, Barisal, Mymensing and Gopalganj zone and Wings are Planning and Maintenance, Bridge Management, Technical Services, Management Services and Mechanical Wing. At the top zones and wings are functional type divisions. Zones and Wings are divided into number of circles headed by a Superintending Engineer SE. The circles are divided into number of Divisions headed by Executive Engineer EE. Divisions are further divided into Sub divisions headed by Sub Divisional Engineer SDE. Sub Divisions are divided into Sections headed by Sub Assistant Engineer SAE. Assistant Engineers work as staff officer in zones, wings, circle and divisions. In the field operational level the the structure is like divisional structure, Example EEs are at the district level.

Planning project and maintenance is done from planning and maintenance wing. Design supports are given by road or bridge design divisions. For quality related testing and audit RHD has a central laboratory, Bangladesh Road Research Laboratory, BRRL. There are

nine field labs in Mymensing, Comilla, Sylhet, Rangpur, Rajshahi, Jessore, Chittagong, Barisal and Rangamati for quality testing in field level. For the training of the officers and staff RHD have Training Center. The officials and staffs are also trained in various training centers of home and abroad.

3.3 Quality Control Strategy

RHD have both long and short term strategy for the development of the road network of the country. These strategies are important of the quality control of the processes involved in road construction and maintenance. Strategies are discussed here so that their impact and lickings of them can be identified. Also to see weather poor quality is rising from poor strategy formulation or not.

3.3.1 Long Term Strategy

The long term strategy for RHD is the road master plan. The road master plan came from the National Road Transport Policy, which was approved by cabinet in 2004. The road master plan was then prepared by the Road Network Improvement and Rehabilitation project-I, RNIMP-II in 2009 and approved accordingly. It is a 20 years plan. The road master plan included the status of the present connectivity. The table 3-1 shows the connectivity of the major ports and divisional head quarters of the country. The redefinition of the connectivity included in the plan and it also indentifies the lack of connectivity of some of the upazilas these are,Mehendiganj (Barisal); Sandwip (Chittagong); Kutubia (Cox's Bazaar); Barkal, Belaichhari, Juraichhari and Langadu (Rangamati); Austagram, Itna and Mithamain (Kishoreganj); Kalmakanda and Khaliajuri (Netrakona); Bishwambarpur, Jamalganj, Sulla, Tahirpur and Dwarabazar (Sunamganj); Asmiriganj (Habiganj). To fullfil the connectivity the missing links are identified. Insufficient carrigway was another identification of the road master plan. After various technical surveys the master plan also identified the road condition, soil map. One of the major finding of the master plan is the effect of over loading. Road master plan found out that over loaded vehicles are in operation in Bangladesh and the overloaded vehicles are severely damaging the roads of Bangladesh. Its suggestion was to establish overload control stations. Road safety was given emphasis in the master plan to reduce loss of

property. Road master plan also identified the local hats/bazars on national high as a source of quality detoriation, suggested solution like rigid (concrete) pavement here. The flexible (bitumeenous) pavements have drainage problem here.

Place	**Function**	**Connections**
Dhaka	Capital	N1, N2, N3, N4, N5, N8
Chittagong	Divisional Headquarters	N1
Rajshahi	Divisional Headquarters	N6
Khulna	Divisional Headquarters	N7
Sylhet	Divisional Headquarters	N2
Barisal	Divisional Headquarters	N8
Chittagong	Sea Port	N1
Mongla	Sea Port	N7
Benapole	Land Port	N706
Banglabandha	Land Port	N5
Burimari	Land Port	N509
Hili	Land Port	Z5503, Z5856
Sonamasjid	Land Port	Z6801
Tamabil	Land Port	N212
Akhaura	Land Port	Z1216
Haluaghat	Land Port	Z2371
Bhomra	Land Port	Not Connected (LGED road only)
Bibirbazar	Land Port	Not Connected (LGED road only)
Teknaf	Land Port	N1

Table 3-1: National Highway functional connections

Now in the present road network of 21,517 km is fixed but now it is necessary to widening of the roads to accumulate the increasing traffic. The road master plan calculated the traffic growth and advised the following projects.

- N1 Dhaka-Chittagong 4 Lane
- N3 Dhaka-Mymensingh 4 Lane (to Mawna)
- N102 Mynamati-Brahmanbaria
- R260 Sylhet-Sunamganj
- Dhaka Eastern Bypass
- Dhaka Western Bypass
- Dhaka Outer Orbital Road
- Upgrading of R750/Z5703 Bhatiapara-Narial –Jessore
- Deep Sea Port to N1

- N1 Chakaria-Chittagong 4 lane
- N8 Dhaka – Mawa 4 lane
- N4 Dhaka – Tangail 4 lane
- N6 Baneshwar – Belephur 4 lane
- N5 Dhaka- Baniajuri 4 lane
- N2 Bhairab – Moulvibazar 4 lane
- N2 Dhaka – Bhariab 4 lane
- N2 Habiganj – Sylhet 4 lane
- N8 Jessore – Benapole 4 lane
- Chittagong By-pass
- N1 - Hatazari Link Road
- N1 2nd Meghna Bridge
- N1 2nd Meghna Gumati Bridge
- N8 Padma Bridge

3.3.2 Short Term Development Planning

Short term development is done by the Annual Development Programs approved by the Planning Commission of Bangladesh. The projects of the ADP are taken on a priority basis considering the financial constrains and economic development plans. RHD has developed the vast majority of the above roads since independence in 1971. Over the past years, the annual allocations to RHD have been broadly constant, at around 3000 Crore Taka per year. The ADP allocation of the financial year 2013-14 and 2014-15 are 2791.47 and 3841.86 Crore Taka respectively. A significant proportion of the expenditure in the road sector was the result of assistance from Development Partners.

Projects are taken to be completed in a defined time period and the resource allocations are done accordingly. The projects have its own project structure, headed by the Project Director. For implementation of the projects have Project Manager and Deputy Project manager. The project personals are responsible for the planning and allocation of resource of the projects.

3.3.3 Short Term Maintenance Planning

Since 2005-06 maintenance programme, RHD introduced a new procedure which streamlined the planning of its maintenance and rehabilitation works, to support their responsibility to actively manage the nation's network of roads and bridges. Each year this system is being further improved and developed in order to improve the selection and prioritisation of maintenance works. "RAMS", short for Road and Bridge Asset Management System, brings together all RHD's current databases and analytical procedures. The final output of RAMS is the RAMS Map: a single GIS based map for each Division which combines all relevant information and shows decision makers where they can most effectively allocate funds for maintenance and rehabilitation. The strength of the RAMS Map is its simplicity. It presents information in a highly visual, graphical format and uses a minimal set of symbols and colours. RAMS relies on output from the Bridge Maintenance Management System (BMMS), HDM, and therefore the data in RMMS. The quality of the RAMS Output is therefore heavily dependent on the quality of the data included in these databases. It should be noted that this Maintenance Needs Report deals only with the needs of roads and road pavements and does not address needs for bridges and structures. The Maintenance and Rehabilitation Needs report presents the results of HDM-4 analysis for National, Regional and Zilla road networks. None of this work is improvement or development work, it is simply the work required to restore the existing road network to its original condition. It should therefore be classified as maintenance work and funded 100% through the Revenue Budget. Rehabilitation is referred to as "backlog maintenance" as it is the result of under-investment in maintenance in the past. Separate budget sub-codes should be assigned for routine maintenance, periodic maintenance and rehabilitation in order that monitoring of expenditure can be effectively carried out. NPV/Cost value for the roads in the report helps to prioritize the maintenance work one another due to financial constrains.

3.4 Quality in Sourcing

Quality is to be imparted in every step of the sourcing process. Quality should be in design, specification, in supplier selection process, tendering process. How quality in sourcing process is imparted in RHD is discussed here.

3.4.1 Design of the Works

The designs of the new works are done following the international standards. For the structural design of concrete structure American Concrete Institute ACI standards are followed. For the road design purpose ASTHO standards are followed.

For routine or minor maintenance works (e.g drainage of water, crack sealing, pothole repairs, pallisading, etc) RHD standard designs have been prepared and these should be adopted. Although minor in nature it is essential that these works are carried out to the required standards to avoid premature failure. For example, if potholes are properly repaired to the required standard then the more expensive periodic maintenance of a road can be deferred for many years. On the other hand if cracks or potholes are not repaired effectively they will prematurely and progressively fail, making periodic maintenance impractical and require early and costly rehabilitation works to the road.

With respect to the periodic maintenance of roads an initial assessment of the treatment they require will have been made by HDM4 in the RHD Annual Roads Needs Assessment Report. This Report, in effect, prioritizes the roads for periodic maintenance within the available budget for this type of maintenance. This does not relieve the Engineer for the works from his responsibility to check and approve the actual works that should be carried out. If, in the opinion of the Engineer, the HDM4 proposals are incorrect (e.g. significant deterioration of the road since the condition surveys upon which HDM4 is based has occurred resulting in the HDM4 proposals being inappropriate) then the correct form of treatment should be proposed by the Engineer to ACE Planning & Maintenance Wing.

In the event that partial reconstruction of the road is required, RHD standard designs should be adopted according to the type of road and volume of traffic using it. Where full reconstruction is required, and for all new road construction (including widening), road pavements must be designed, with the design calculations being checked and approved by the Engineer and subsequently filed by him as part of the document control system. In particular, the new road pavements must be designed to be above the relevant Highest Flood Level (HFL) as defined in the RHD Pavement Design Guide. For all road contracts where a new surface is to be laid a design must be undertaken for the required new

carriageway markings and traffic signs. These must be **designed** in accordance with the BRTA Traffic Signs Manual.

3.4.2 Drawings

Divisions have limited capacity for the production of engineering drawings. For this reason RHD Standard Drawings have been prepared, and these should be referred to and be included as part of every road Contract. The Divisions have available to them GIS mapping on request from HDM Circle. These maps should be used to create a location drawing for each contract showing, for example, the start and end point of road contracts or the location of a new structure. This location drawing must be included in every contract. In addition, in the absence of topographical mapping and plan layouts, every road contract must include the location and extent of the major work items showing the start and end chainages (in bar chart form).

Where surface water drainage is required (see RHD Design Advice Notes) and is to be included in a works contract, a longitudinal plan showing the gradients and outfalls must be included within the contract documents. This can be in diagrammatic form but must show the relevant information required by the Contractor for the drainage to be constructed by him Where special minor structures are to be included in road contracts for which standard drawings are not available (e.g. large retaining walls) then design drawings approved by the Engineer must be included within the contract documents.

3.4.3 Bills of Quantities

For every item of work within a Contract where an estimate has to be made of the quantities involved, calculations must be made that are checked and approved by the Engineer and filed in the document control system. Where appropriate such calculations must be supported by field measurements, in particular with respect to earthworks, pothole repairs and bituminous base course regulating course. Where a nominal thickness of bituminous surfacing forms part of the Works, then the corresponding item in the BQ must specify the compacted thickness that the Contractor is to provide. All BQ items must correspond to the relevant pay items in the RHD Specification or the Particular Specification for the Contract. Under no circumstances should a BQ item include any

form of specification for either materials or workmanship. All BQs must be prepared using the Field Module of the Central Monitoring System.

3.4.4 General and Particular Specification

In May 2001 RHD Standard Tender Documents were issued that included Volume 3: Technical Specifications. In due course this will be revised and re-issued as the RHD General Specification. In the meantime all RHD Contracts must include a statement that Volume 3: Technical Specifications is deemed to be the RHD General Specification. This General Specification is the basis of all RHD road contracts supplemented where necessary by a Particular Specification for an individual contract. Due to the time that has elapsed since publication of the RHD Standard Tender Documents various amendments to the Technical Specifications have been proposed. Where approved by CE/RHD these standard amendments are included in the Particular Specification of all RHD Contracts. It is now mandatory that within the Particular Specification the attention of the Contractor is drawn to the quality control tests that must be carried out by him on both his materials and workmanship as part of the Contract. In addition to this it is necessary to specify that that the site laboratory is to be located within the limits of the Works contract or at such other location as agreed by the Engineer in writing.

3.4.5 Tender Documents

Central Procurement and Technical Unit, CPTU Standard Tender Documents that are to be used by RHD are supplied to the Divisions in an electronic format that are compatible and integral with the RHD Central Monitoring System. These standard documents incorporates the standard clauses and conditions required by RHD in every contract and simply requires the Engineer to insert the contract specific details for the works contract for which tenders are to be invited. The standard clauses required by RHD covers such issues as the employment of females on contracts, health and safety requirements, environmental controls and other contracts requirements approved by CE/RHD from time to time. Accordingly, it is essential that in the preparation of Tender Documents the Divisions uses the latest and current version of the Standard Tender Documents for the type of contract to be undertaken. These Standard Tender Documents and the contract specific details are checked and approved prior to the floating of tenders.

3.4.6 Tendering Process

The standard processes mentioned in the Public Procurement Rules, PPR-2008 are followed in RHD. Most of offices use to go for tendering in the traditional procurement process but the organization has now moved to e-GP, electronic Government Procurement. The contract is awarded by the proper authority to the lowest bidder in case of open tendering. Other tendering methods like limited tendering method (LTM), Request for Quotation (RFQ), direct procurement and two stage procurement are also followed in RHD.

3.5 Quality in Construction

The Quality Assurance Plan of RHD covers the major issues that affect the quality of works achieved within RHD contracts, namely the preparation of contract documents and quality control during the works. Responsibility for checking and approving all designs, tender documents and quality control tests on site rests with the Engineer for the Contract and through him the Engineer's Representative. Within this QA Plan, **quality control** procedures are needed at each stage as follows:

During Works Contracts

- The Contractor is required to perform quality control tests on all materials and workmanship of the type and frequency called for under his Contract
- These are to be undertaken in accordance with the RHD Standard Test Procedures, such tests being witnessed and countersigned by an RHD representative
- Off-site laboratory tests are to be undertaken by the Contractor on site samples where appropriate testing equipment is not available at his on-site laboratory (e.g. bitumen extraction, Marshall tests, etc)
- Site samples are to be tested in an independent off-site laboratory to confirm (or otherwise) tests undertaken by the Contractor
- The Contractor may only proceed with successive road pavement layers subject to authorization by the Engineer following satisfactory and certified quality control tests on the underlying layer
- Interim Payment Applications from the Contractor must be supported by relevant quality control test reports certified correct by the Engineer's Representative

- Road contracts will be subject to post construction tests on a sampling basis to check compliance with the specification and Contract Documents

This QA Plan defines the roles and responsibilities of the key RHD staff involved in road contracts, and outline the procedures that should be adopted by them to achieve the required quality control in these contracts.

3.5.1 Construction Management

Construction management is a complex task. Constructions of new roads and bridges have to follow certain procedures to maintain quality. The quality Assurance plan of the RHD has given the flow charts to maintain quality. These flow charts are given in figure 3-1, 3-2 and 3-3. Despites the project team of RHD also uses project management tools to allocate time, resources, manpower. It also does the complex task of adjusting the time and resources to timely completion of work.

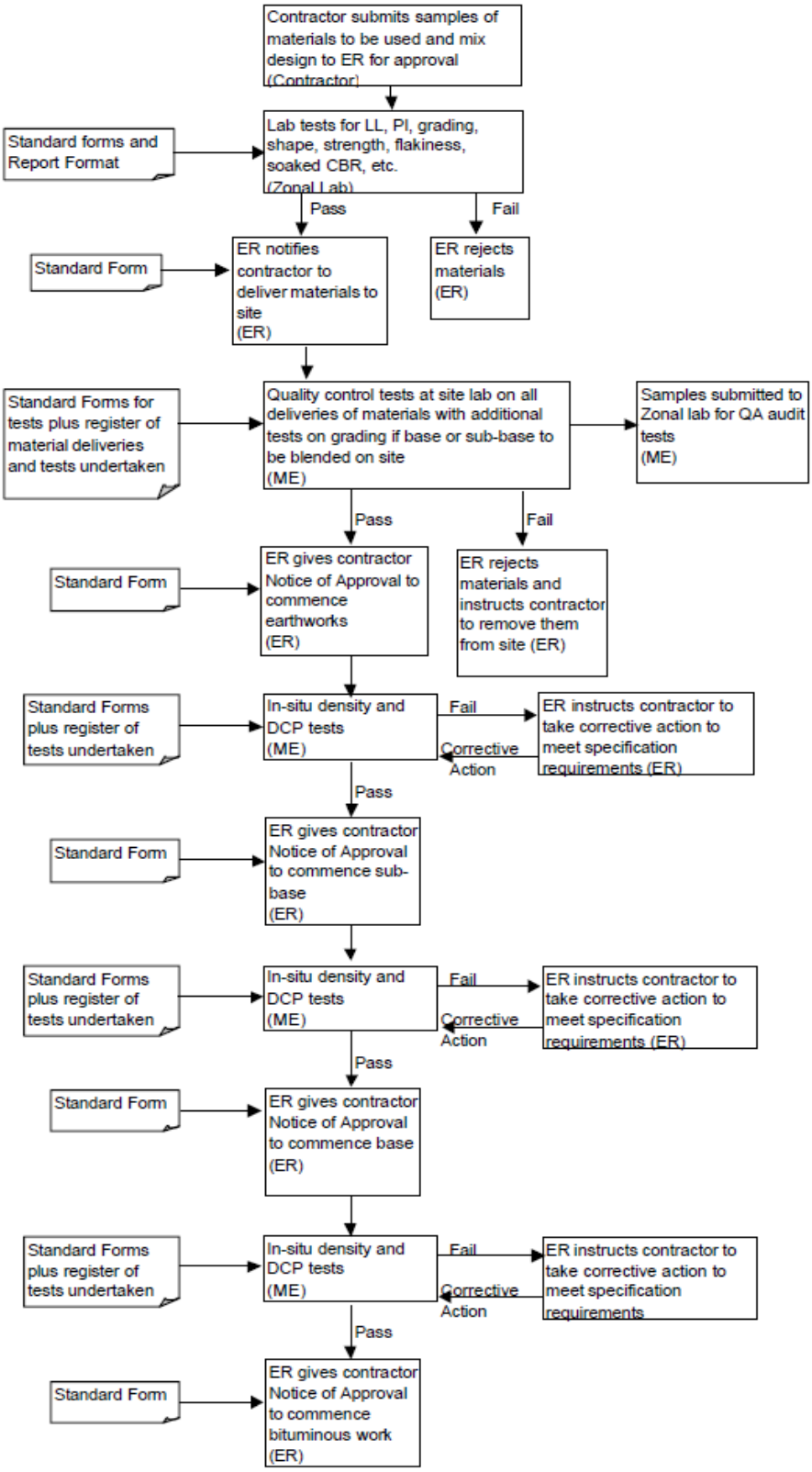

Figure 3-1: Flowchart for Earthwork, Sub-base and Base

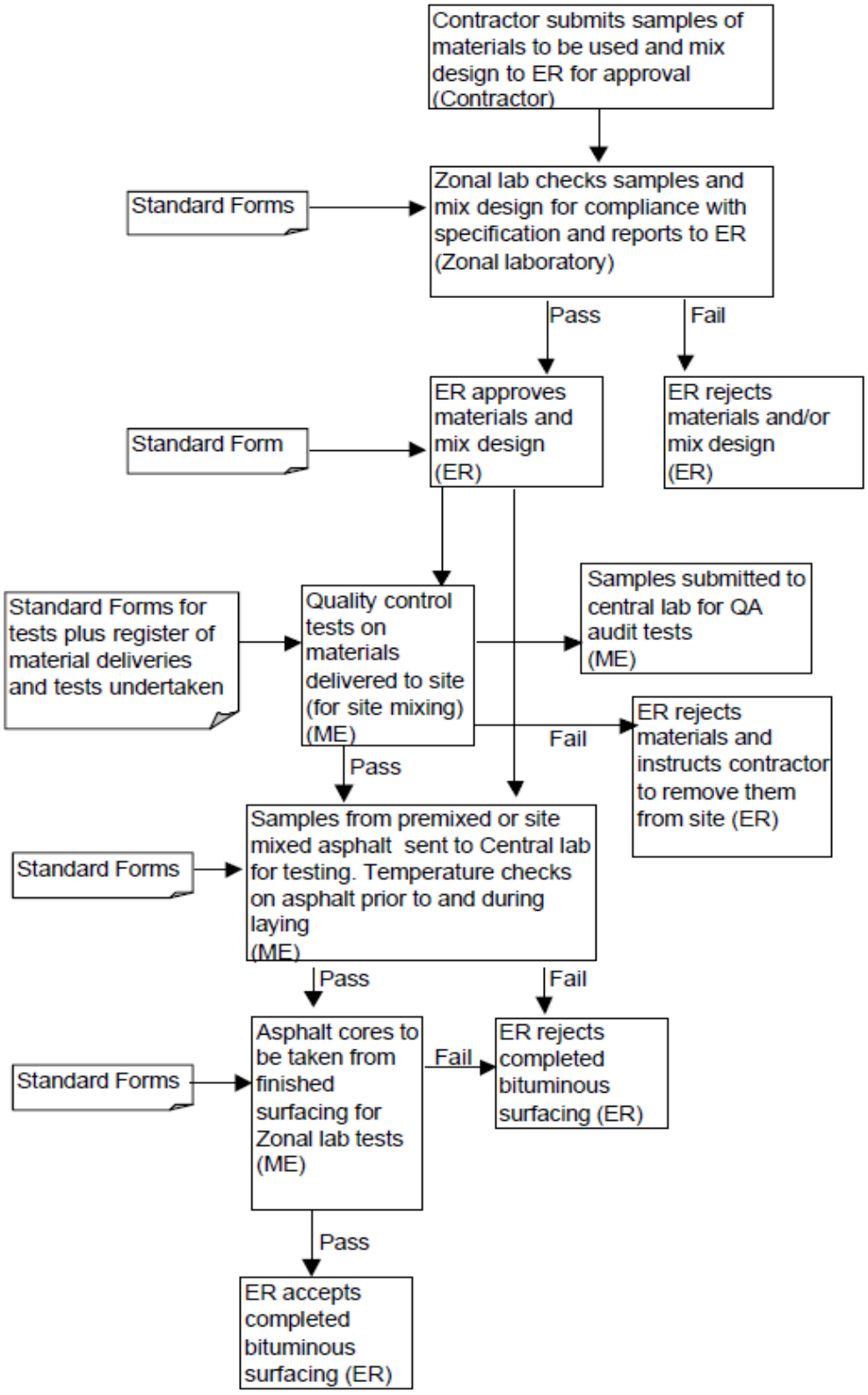

Figure 3-2: Flowchart for Bituminous Surfacing

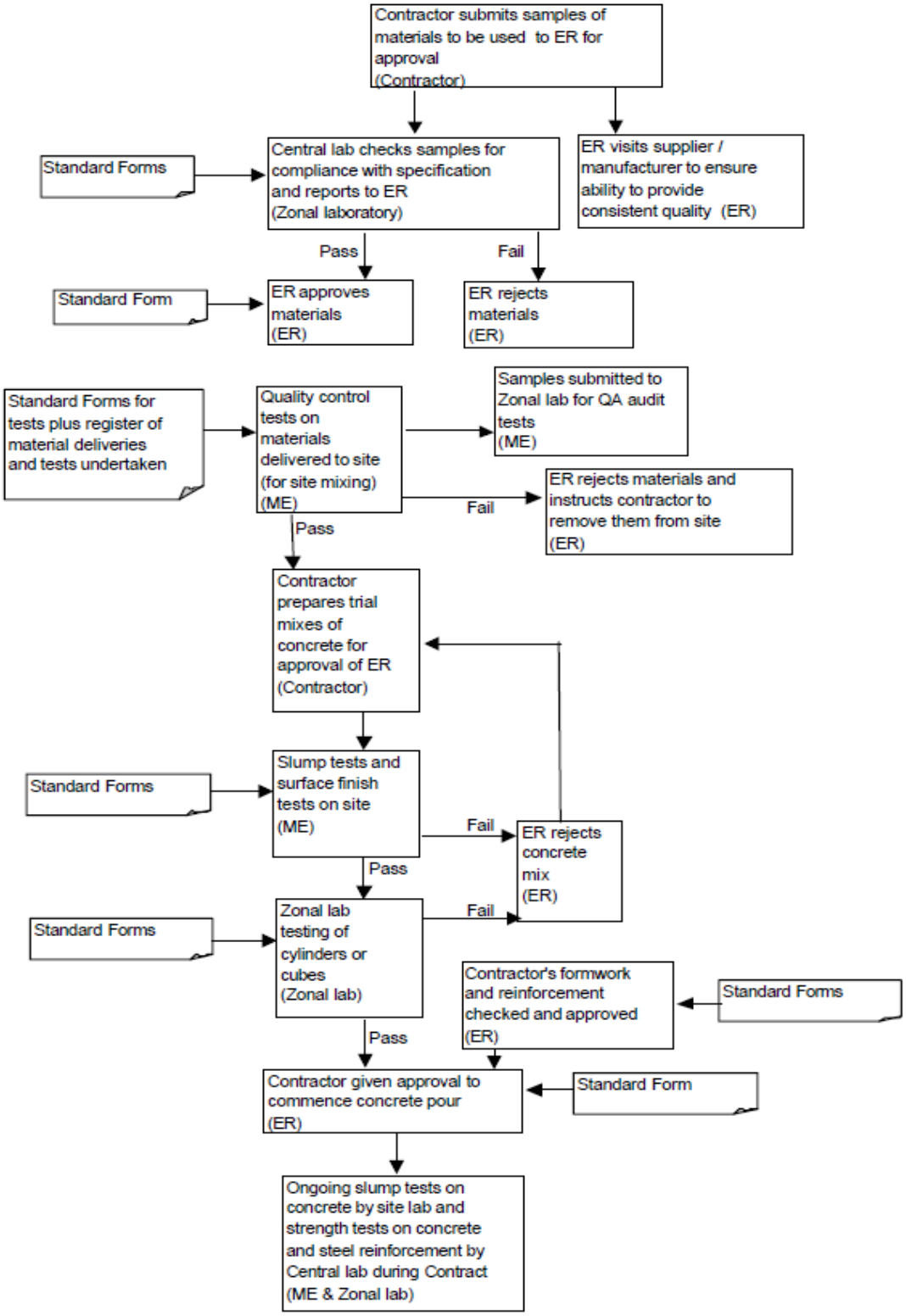

Figure 3-3: Flowchart for Structure

3.5.2 Site Laboratory

Under all RHD contracts a site laboratory is to be established by the Contractor who is responsible for carrying out quality control tests on his materials and workmanship to demonstrate compliance with the specifications for the Contract. This laboratory should be established before the Works commence and within the limits of the Works area. Subject to the approval of the Engineer some of the tests may be carried out at an alternative laboratory containing more advanced testing equipment.

All tests must be witnessed by the ER or someone appointed by him for the purpose (the 'Materials Engineer'). The tests required and their frequency is contained in Appendix 2. Appropriate test forms must be used and both these and the test result forms at Appendix 3 must be signed by the person carrying out the test and representatives of both the Contractor and the Engineer. The ER must check on a weekly basis that the required tests on all materials delivered to site and the Contractor's workmanship have been carried out and that the results of such testing are correctly recorded and filed within the site laboratory.

3.5.3 Quality Control Tests

The quality control tests listed in Quality Assurance plan, are the tests required by the RHD General Specification. Where works are to be undertaken that are not covered by the RHD General Specification then the Contract must include a Particular Specification for such works, including the tests, frequencies and required results for those tests, both for the materials and workmanship for these works. In addition to these tests, where the Contract requires particular materials to be used but the specification does not require tests to be carried out on those materials, then it will be the responsibility of the Engineer (through his support staff) to ensure that the Contractor provides those materials to the requirements of the specification. For example, where the Contract requires thermoplastic paint to be used the contractor must use a proprietary brand of thermoplastic paint and not simply road paint.

Quality control tests fall into three categories:

- Tests on materials prior to and during construction
- Tests on the quality of workmanship during construction

- Tests on the finished works after construction

In the event that the quality control tests demonstrate that the materials or workmanship do not meet the requirements of the specification, the Engineer's Representative has no alternative but to reject them and instruct the Contractor to replace them at his own cost. All quality control tests must be carried out at the earliest opportunity both to avoid delays to the Contractor and to minimise any abortive works.

3.5.4 Quality control tests on material samples

Prior to the commencement of the Works, tests must be carried out by the Zonal laboratory on material samples (or mix designs) submitted to the Engineer for his approval by the Contractor in advance of them being taken on to the site. Given that the Zonal laboratory may be testing samples from a number of different contracts at the same time, it follows that within the laboratory itself there must be a management system to ensure that samples are correctly registered, tagged, tested and recorded for the separate contracts. Similar tests must be carried out by the Contractor on all such materials subsequently delivered to site in the site laboratory (supervised by the Materials Engineer) with additional tests on those materials carried out on a sampling basis at the Zonal laboratory as a quality control check.

3.5.5 Quality Control Tests on Workmanship

To a large extent these tests are required to ensure that the approved construction materials are correctly mixed, placed and compacted during the works. With respect to road pavements it is essential that each layer is tested and approved before the Contractor is allowed to place the next layer, since failure of an underlying layer will inevitably result in failure of the layers above it.

Accordingly, the Contractor may only be permitted to commence work on a particular layer when the underlying layer has been approved in writing by the Engineer's Representative. Standard forms for this are included at Appendix 4.

3.5.6 Mixing of Materials

Where on-site mixing is employed by the Contractor, the grading and proportioning of the materials must be strictly controlled so that at all times the final mix complies with

the design mix that has been approved by the Engineer. To this end careful batching of the materials must be employed by the Contractor prior to placing them in the mixer. Under no circumstances should the proportioning of mixes be undertaken by laborers taking materials from stockpiles on a random basis.

Where granular materials are mixed on site to form sub-base or base material, and prior to the addition of bitumen or cement to granular mixes to form bituminous surfacing or concrete, samples of the granular mix should be taken in the presence of the ER's support staff for grading and other tests in the site laboratory.

Whether mixed on-site or off-site, the ER's support staff must take samples of all bituminous and concrete mixes for testing at the Zonal laboratory in accordance with the requirements of the Specification. Inevitably the results of these tests will not be known until a considerable period of time has elapsed after the materials have been placed and compacted. Where the results of these tests demonstrate that the materials do not comply with the Specification further intrusive and /or non-destructive tests must be carried out on the completed works for the Engineer to decide whether or not to reject the works.

Concrete target strengths are to be calculated using the statistical approach set out in the Contract

3.5.7 Placing and Compacting of Materials

Premature failure of the works will occur unless the materials are correctly placed and compacted (where appropriate) in accordance with the specifications. In the case of road widening work, premature failure will also occur if required cross drainage structures or drainage layers are not provided. With respect to road pavements, this essentially means the compaction of each layer to the required density (typically 98% of MDD) to achieve the necessary CBR to support the next layer. In the case of Dense Bituminous Surfacing or carpeting the required degree of compaction can only be achieved when rolling takes place while the material is still hot and within the specified temperature range for compaction. Accordingly the ER must ensure that field density measurements are taken by the Contractor at the appropriate times to demonstrate that the underlying layers are properly compacted (or corrective measures taken if not), and that rolling of the bituminous surfacing is undertaken within the correct temperature range.

3.6 Quality in Audit and Review

Audit and review is important. The RHD General Specification requires cores to be taken from completed bituminous surfacing work and for laboratory tests to be undertaken on these samples to determine whether or not they comply with the requirements of the specification. Amongst other things these tests will include Marshall Stability, determination of bitumen content and the grading of aggregates in each sample. In addition to this the laboratory will measure the compacted thickness of the bituminous layer for compliance with the design or relevant BQ item in the Contract. The taking of cores is to be undertaken by the Contractor and all tests on those cores are to be undertaken by an off-site laboratory approved by the Engineer, with all costs associated with this testing being borne by the Contractor. Where cores have been taken from road pavements Dynamic Cone Penetration (DCP) tests are to be undertaken for the underlying layers through to the sub-grade to determine both the thickness of these layers and their respective CBR values. These tests are to be undertaken by the ER or his support staff. In the event that the DCP tests show that the underlying pavement layers do not have the required thickness or CBR or if the bituminous cores do not meet the requirements of the specification or thickness required by the Contract, the Engineer will immediately notify CE/RHD requesting that an inquiry be held to determine what course of action should be taken.

CHALLENGES AND SCOPE OF IMPROVEMENT

4.1 General

There are many challenges in the way of quality control. The challenges comes both from inside and outside of the organization. Some problems like the limitation of resources are national problems. There are also scopes of improvement in some cases. These issues are discussed in the following sections.

4.2 Organizational Aspects

Most of quality related issues arise within the organization. For this reason the organization should be analyzed in various aspects to determine the quality related problems. The main aspects to be considered are human recourse, culture of the organization, organization's current position.

4.2.1 Human Resource Development

Human resource is the main resource of an organization. The government of Bangladesh Recruits the workforce and provides the required facilities. The facilities are in some cases not sufficient but as it is a government decision, this issue will not be discussed here. Recruitment is also a government issue. The first class officers of RHD are recruited by Bangladesh Public Service Commission BPSC. The recruitment is done for the entry first class post of Assistant Engineer. BPSC also recruits second class officers Sub Assistant Engineers. The first and second class officer recruited following rules and regulation of the government and they are the main workforce of RHD for implementing the construction and maintenance work. The higher posts are filled by promotion. The second class officers also get promotion to first class post, 33% of Assistant Engineer post is filled by promotion. Third and Fourth class employees are for support and recruited by the government. The hierarchy of Roads & Highways Department which was discussed before is shown below,

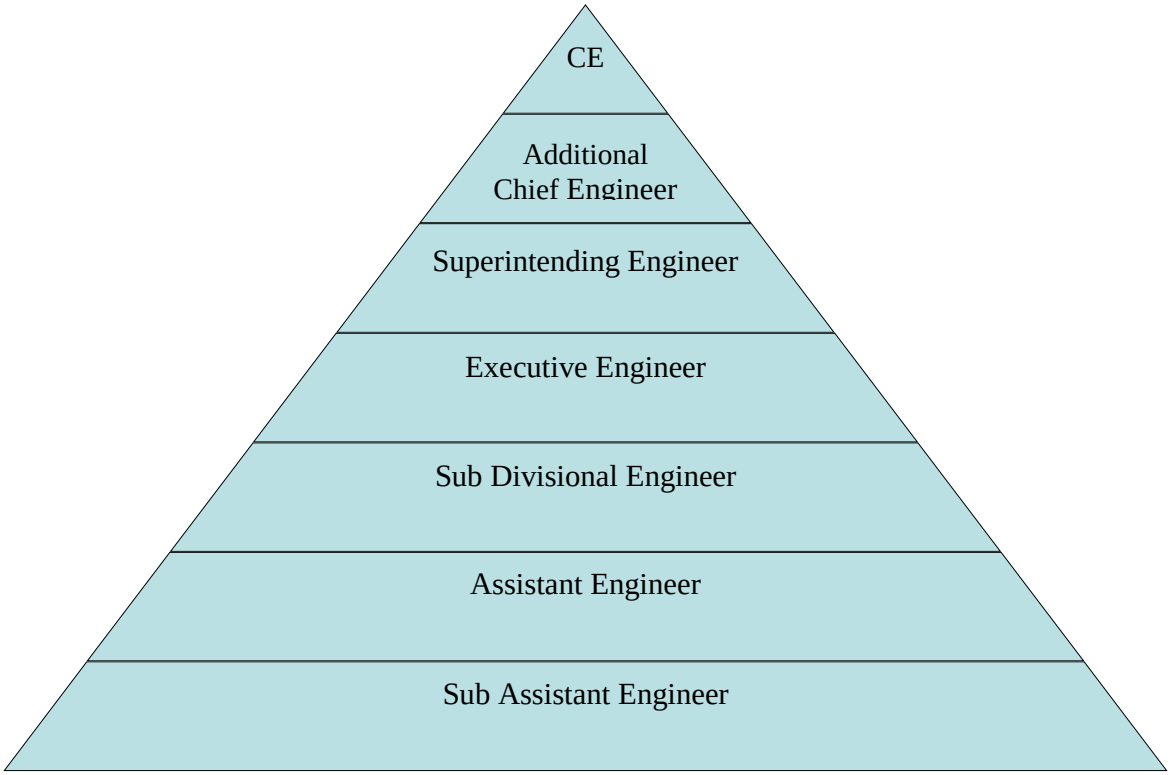

Figure 4-1: Organizational Hierarchy of RHD

The recent status of posts is shown Table 4-1. The table above gives idea that at operational level, from Executive Engineer to Sub Assistant engineer many posts are vacant. Vacancy is also there at the top strategic level also. The quality operation with such vacancy is impossible. There is no recruitment in 3rd & 4th class staff for last 20 years. The absence of support staff is also a problem for quality control. From the list above it can be seen that very few of the 3rd and 4th class employees are permanent. Most these support staffs are on work charged basis, they are not permanent. This staffs do not have the job security and they also have less job satisfaction as they do not get the required job facilities. For better service these support staffs should be recruited on permanent basis.

Post	No. of Sanc. Post	Regular Employee	Vacant Post
Class I			
Chief Engineer	1	0	1
Additional Chief Engineer, Civil	15	10	5
Additional Chief Engineer, Mechanical	1	0	1
Superintending Engineer, Civil	38	27	11
Superintending Engineer, Mechanical	11	6	5
Executive Engineer, Civil	107	94	13
Executive Engineer, Mechanical	20	13	7
Sub Divisional Engineer, Civil	168	112	56
Sub Divisional Engineer, Mechanical	43	9	34
Assistant Engineer, Civil	194	192	2
Assistant Engineer, Mechanical	22	16	6
Total Class I	620	480	140
Class II			
Sub Assistant Engineer, Civil	628	517	111
Sub Assistant Engineer, Mechanical	128	99	29
Total	756	616	140
Class III (Work charged/Temporary)	4535	828 (2890)	-
Class IV (Work charged/Temporary)	3300	389 (4000)	-

Table 4-1: Employee Status of RHD

Roads and Highways department has two sub cadre one is the civil sub cadre and mechanical sub cadre. The scope of job enrichment promotion is reflected in histograms in Figure 4-2 & Figure 4-3. For civil engineers the scope of from assistant engineer to executive engineer is smooth but after that the scope of promotion narrows down. Same is the case for mechanical engineers. There is another problem no of entry post is less so the structure is not in proper pyramid shape. To increase the scope of promotion the organizational structure can be expanded.

Training is important for HRD. RHD has a training center. It is providing training on various financial and management issues. RHD Training Center is giving training on various topics but quality related training is absent. There is also scope of training for staffs in home and abroad. But the training is not uniformly distributed among the staffs. Another problem is 3rd and 4th class employee gets less or no training.

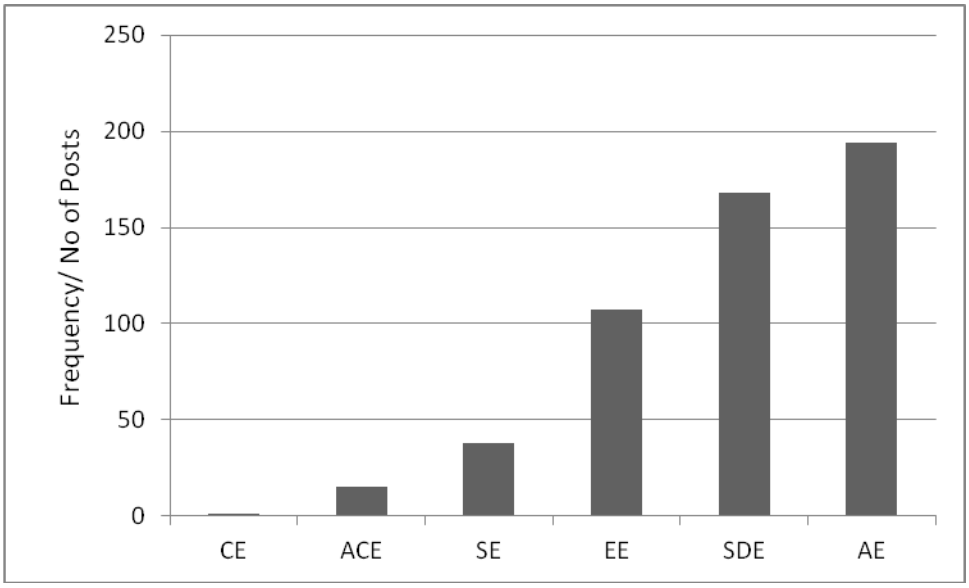

Figure 4-2: Post Status (Civil)

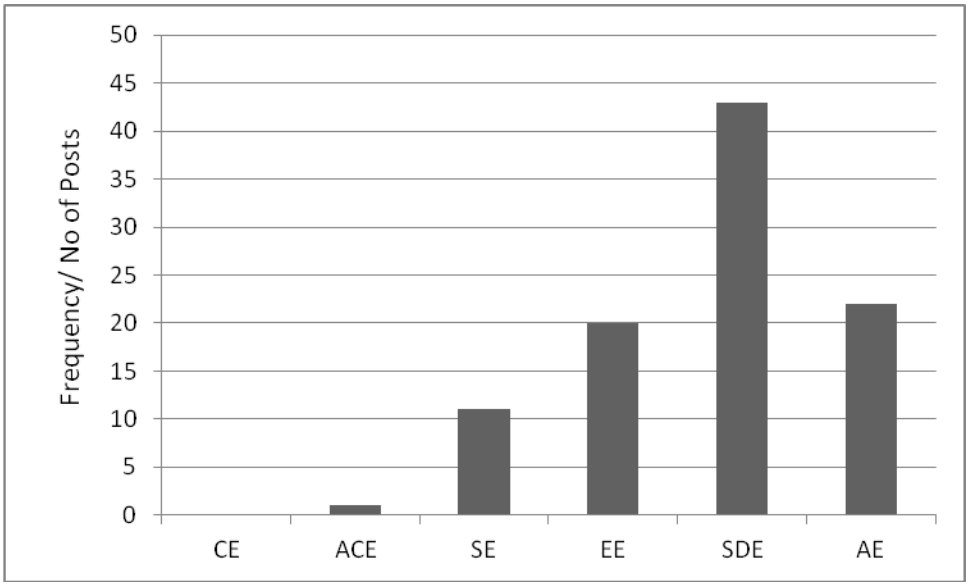

Figure 4-3: Post Status (Mechanical)

4.2.2 Organizational Structure and Culture

As mentioned earlier RHD is a government organization under the Road Transport and Highways Division, RTHD of the Ministry of Road Transport and Bridges. Being a government organization the processes of the organization is bureaucratic in nature. For any approval or order of the government bureaucratic process is followed. RHD is headed by the Chief Engineer; he is the Chief Executive Officer of the organization. RHD is divided into ten operational zones and five wings, which are headed by Additional Chief

Engineers ACEs. The operational zones in the field are Dhaka, Chittagong, Comilla, Sylhet, Rajshahi, Rangpur, Khulna, Barisal, Mymensing and Gopalganj zone and Wings are Planning and Maintenance, Bridge Management, Technical Services, Management Services and Mechanical Wing.

The organizational culture in any department of Bangladesh is bureaucratic in nature. The organizational culture cannot be changed overnight. The technical decision making power is delegated at different level of the organization. It helps to maintain proper acceleration of the works. But in case of planning and approval of major projects the process is lengthy. It is shown below,

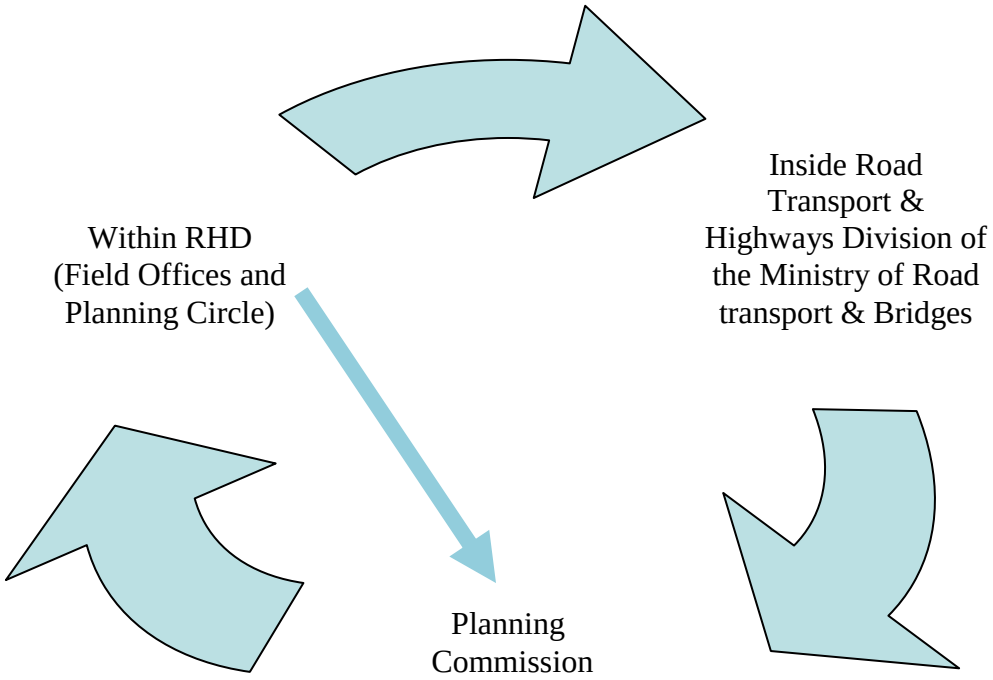

Figure 4-5: Departments Involved in Planning

The planning of projects involves every field level office and planning circle of RHD. It is a long process if ministry steps are avoided then the process will be easy and less time consuming. The organizational structure can be expanded for better project planning. The offices of RHD like Planning, Maintenance, HDM, BRRL, Training Center, PPP Cell, Procurement, and Design should be restructured.

4.2.3 Organizational Position

Organization position can be determined by SWOT (Strength, Weakness, Opportunity and Threat) analysis. The SWOT analysis of RHD is performed below,

Strength	**Weakness**
• Highly competent Engineers • Experience of the organization • Own workforce for maintenance work • Modern procurement system (e GP) • e DPP implementation • Attracts huge amount of FDI	• Budget scarcity • Reputational Problems • No recruitment in 3rd & 4th class staff for last 20 years • Outdated equipment • Absence of Quality Audit • Lack of required training in technical field
Opportunity	**Threat**
• Regional connectivity • Widening and upgrading of roads • New concepts of highway around the world • Adoption of latest technologies • Cost effective and durable construction materials • Rigid pavement concept in Bangladesh • Public Private Partnership, PPP Financing of projects • Road fund for Maintenance	• Weather of the country (prolonged rainy season) • May lack personnel in future • Right of Way encroachment • Political Uncertainty • Works of RHD performed by other organizations.

Table 4-2: SWOT Analysis of RHD

To develop safe, cost effective and well maintained road network RHD should overcome the weaknesses and work with integrity to minimize threats. From analysis above it can be seen that it has the ability to perform its mission.

4.3 Planning

4.3.1 Long Term Planning

Road master plan is a quality long term plan for quality road construction. It has identified and given solution to many of the problems. Road master plan was for 20 years, after five years from 2009 the initial projects taken are not completed. The road master plan suggested many priorities, which still remains as problem. These things should be considered immediately. Following are the prioritization fixed in the Master Plan,

- Recurrent (maintenance) expenditure should have the first priority, and full needs should be planned for on an annual basis;
- The rehabilitation of National Highways, Regional Roads and Zila Roads must be considered a priority, as delay will increase the costs of recovery;
- Road and bridge projects that are related to traffic growth should be programmed according to dates that they are needed;
- Bridge replacement and repair programmes are a priority, but have to be phased in order to respect human capacity constraints in RHD; and
- Axle load control is of the utmost priority.

The rest of the projects suggested have to be completed within the next fifteen years. The project management problems are discussed in separate section. To fulfill the commitment learning is necessary. The suggestion of road master plan like axle load control is not in operation yet, just the law and regulation if formulated. Maintenance given the most priority but still maintenance has limitations. Rehabilitation of the major national and regional highway is not complete.

4.3.2 Short Term Planning

The short term planning like project planning consumes time due to the bureaucratic nature of the processes. It cannot be avoided as many part of the government RHD, ministry and planning commission are involved in planning. Cross functional team work is needed to improve the efficiency. But the planning and design are done maintaining the international standards. The maintenance planning as said earlier is not given the top

most priority. The overall maintenance needs (Based on Needs report 2012-13) including the ongoing project is given in table below. The period 2012-13 is selected because in this period the poor quality of roods become national issue.

Work Type in core Taka	Financial Year					Total
	1	2	3	4	5	
	2012-13	2013-14	2014-15	2015-16	2016-17	
Routine Maintenance	244.883	518.199	546.976	585.536	629.542	2525.137
Periodic Maintenance	2271.676	486.745	402.095	262.824	140.387	3563.726
Partial Reconstruction	2201.855	985.772	379.575	289.676	242.642	4099.520
Full Reconstruction	2372.968	19.198	3.622	9.002	23.253	2428.042
Total	7091.382	2009.914	1332.268	1147.038	1035.824	12616.430

Table 4-3: Overall Maintenance Needs

The scatter plot of the year wise need gives is constant for routine maintenances is constant i.e. a constant amount of money is needed for routine maintenance. On the other hand periodic maintenance scatter plot gives decreasing trend. It means if the needed periodic maintenance and other amount is spent in the first year the maintenance need in the subsequent years will reduce.

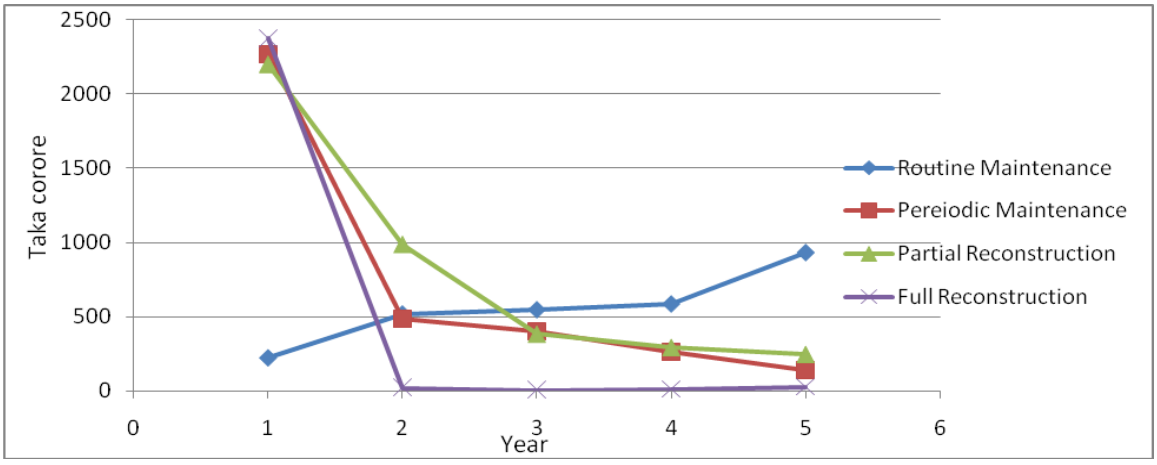

Figure 4-6: Overall Maintenance Scatter Plot.

The immidiate maintenance need in corore taka of the year 2012-13 excluding the on going projects are given in table below,

Routine Maintenance	Periodic Maintenance	Maintenance Backlog		Total need
		Partial Reconstruction	Full Reconstruction	
172.122	138.474	1236.89	1185.282	3979.133

Table 4-4: Immidiate Maintenance Need

The Maintenance alocation of the year financial year 2012-13 was 704.9 corore taka. It was not quiet enough for maintenance. The comparison of need and alocation is shown below. The allocation is only 18% of total need.

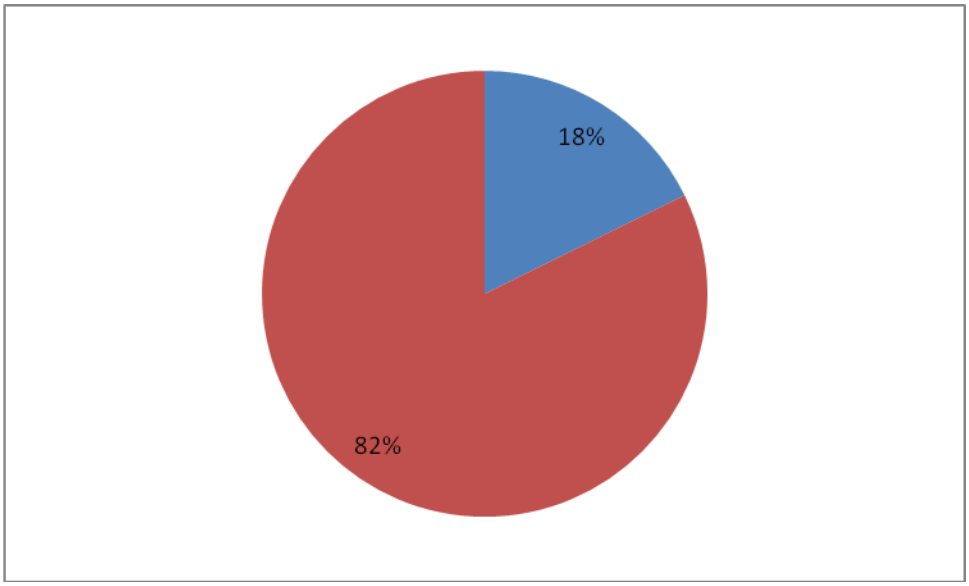

Figure 4-7: Comparison of Allocation and Need

The allocation for maintenance has increased recently and the increase is shown in figure below,

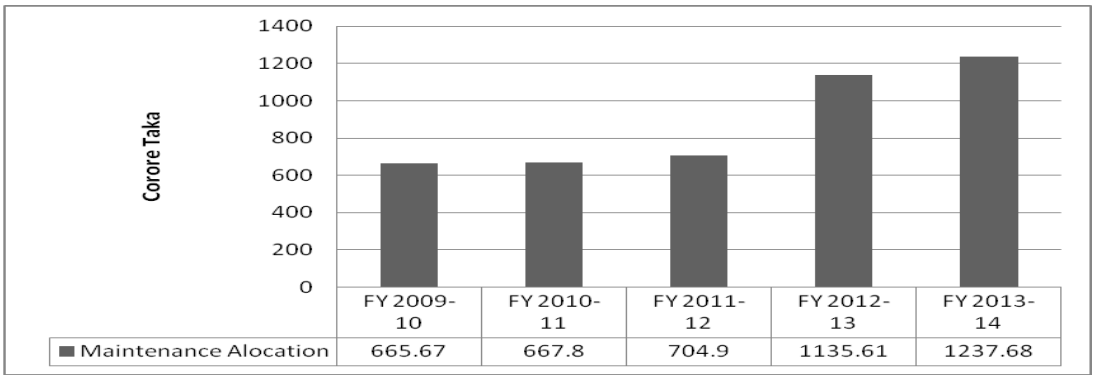

Figure 4-8: Year wise Allocation against Maintenance Need

It is promising that the maintenance allocation has increased but still the amount is below the need. Besides the maintenance allocation also includes the emergency works and the dues of the previous years. It is also a great concern for RHD that there is excessive amount of dues due to emergency repair during festival and natural calamities. The emergency works during the festivals and natural calamities cannot be termed as maintenance, it is rather temporary repair. The maintenance need and allocation is given in Table 4-5 and Figure 4-9.

Financial Year	2009-10	2010-11	2011-12	2012-13	2013-14
Immediate Maintenance Need	4,004.8	3,399.4	3,851.1	3,979.1	7,773.0
Maintenance Allocation	665.67	667.8	704.9	1135.61	1237.68

Table 4-5: Maintenance Need Vs Allocation

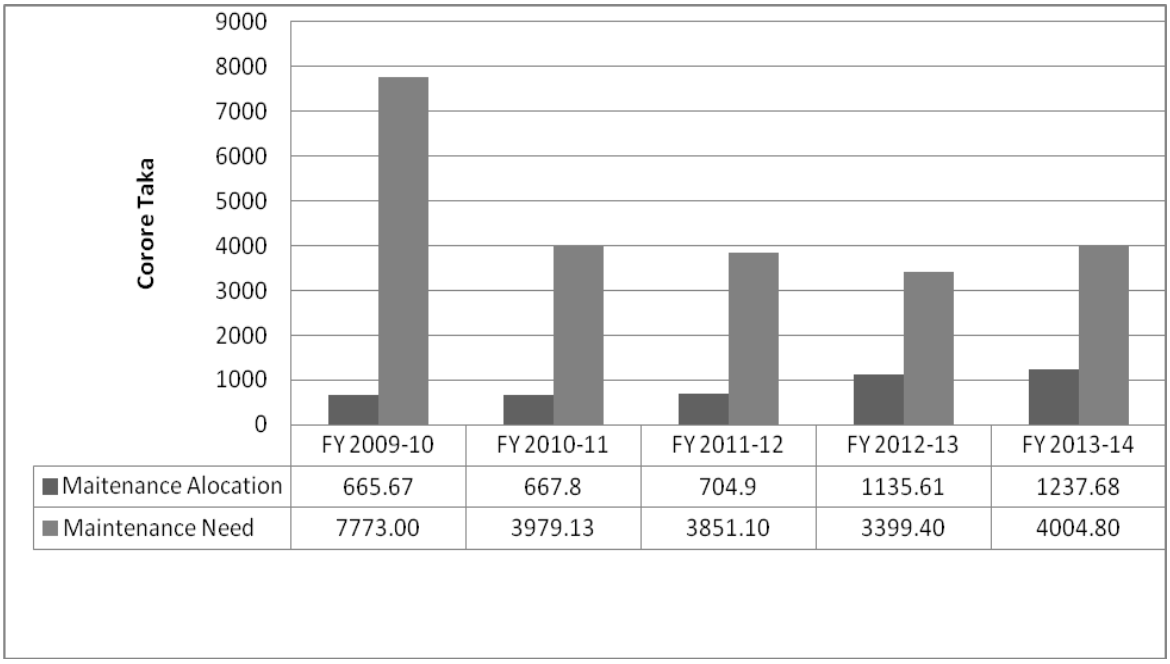

Figure 4-9: Maintenance Need Vs Allocation

4.4 Procurement

The introduction of e-GP has limited the corrupt and fraudulent practice by the officers and the contractors. Now RHD have performing 100% e-GP tendering. The processes of the tendering followed are standard. The documents and standards are derived from European standard like International Federation of Consulting Engineers, FIDIC and New Engineering Contract, NEC. But there is lacking in the rules, PPR-2008 suggest the lowest bidder is to be awarded by tender evaluation committee. If the tender evaluation committee does not approve his bid then statue law permits him to go to court. Then the whole process will be hanged.

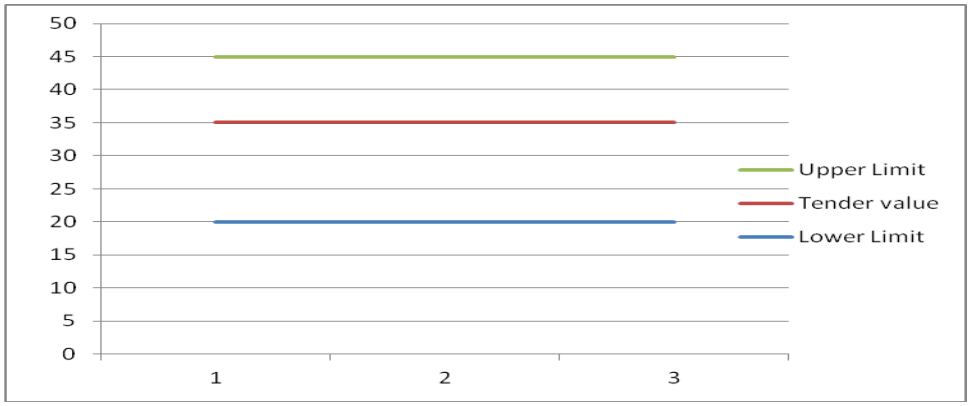

Figure 4-10: Item Specific Upper and Lower limit.

Due to overcome the low cost quality there must be a minimum bar of bidding rate of every item. The whole lot or package of work should have lower limit but the every item should have lower limit. If the package have lower limit then it may be vulnerable to front loading (The item which is to be performed up front is given excessive rates and the supplier sometimes do not perform rest of the work) and less quality in any specific item. When the estimate is prepared then it should have control chart showing the upper, average and the lowest values for every item like Figure 4-10. By this the whole life costing concept can be taken into consideration in procurement.

4.5 Construction Management

Flowchart and Check list are maintained in construction management for quality impartment and management. Also world recognized standards and machineries are used in construction management. Besides these the progress of the ongoing projects are not

up to the mark. For identify the problems two main projects, The Jaydevpur Mymensing Road Improvement Project and the Dhaka Chittagong 4 laning Project is selected. The projects are fully government funded. Before implementation the lack of ability in forecasting the actual future need and the long approval project made the project life period to increase and the project to be revised. The progress of projects in the year 2012-13 and year 2013-14 is given below,

Project	Project Cost	RADP Allocation for 2012-2013	Actual Exp. During July-December 2012-2013	Cumulative Expenditure upto December 2012
4 Laning of Dhaka-Chittagong Highway (Daudkandi-Chittagong Section) (Revised) (1/1/2006-31/12/2014)	319029	50000	19747	84487
Improvement of Joydebpur-Mymensingh Road (01/07/2010-30/06/2013)	99210	13000	5047	26415
Project	Project Cost	RADP Allocation for 2013-2014	Actual Exp. During July-March 2013-2014	Cumulative Expenditure up to March 2013
4 Laning of Dhaka-Chittagong Highway (Daudkandi-Chittagong Section) (Revised) (1/1/2006-31/12/2014)	319029	50000	20461	132657
Improvement of Joydebpur-Mymensingh Road (01/07/2010-30/06/2013)	99210	41426	18293	51760

Table 4-6: Progress of Selected Projects (taka in lacks)

The financing of in Dhaka Chittagong project is proportional to the completion time. The Dhaka Chittagong 4 laning project have project revised life period of 9 years, the current financing cover completion within 7 years. The financing of in Joydevpur Mymensing project is not proportional to the completion time. The Joydevpur Mymensing project

have project life period of 3 years, the current financing cover completion over 7 years. The problem was covered as the allocation increased next year but the completion period is extended. The allocation is ok but the progress of the year 2012-13 is 78.98% and overall progress is 28%. The progress in year 2013-14 is 54.56% and overall progress is 41.58%. The progress of Joydevpur-Mymensing Road Improvement project in 2012-13 is 77.65% and overall progress is 26.62%. The progress of the project of year 2013-14 is 58.87 and overall progress is 52.17%. There are many reasons of poor quality. From the progress report the projects tell that the there are issues related to poor relationship management due to low cost sourcing, and land acquisition problem at the early stage of project.

4.6 Audit and Review

The audit and review system is weak in RHD. For quality in construction third party audit is important. BRRL was nominated by CE as the quality control auditor of RHD. But no fund is available for quality control audit. Without the third party audit quality in construction cannot be imparted. Review is necessary for future improvement. Monitoring circle of Planning and Maintenance wing has evaluation division to evaluate the works executed. But their activity is one off just after the project. Long term evaluation is necessary. Mainly the quality control field labs are now not sufficient to carry out field tests. There are some tests which are easy to conduct and frequently conducted these tests facilities should be established in the field divisions. Complex tests should be performed at the field labs. Field labs can be established in every field circle. Central Lab BRRL should have capacity of special tests and research.

4.7 Towards Total Quality Management, TQM

Total Quality Management, TQM is a new concept. It is being widely used in private sector organizations. Public sector organizations have not yet considered it in their operations. Total Quality Management, TQM is to impart quality in every value adding point in an organization. For imparting TQM in RHD the main causes of problem are identified and showed in cause effect diagram below,

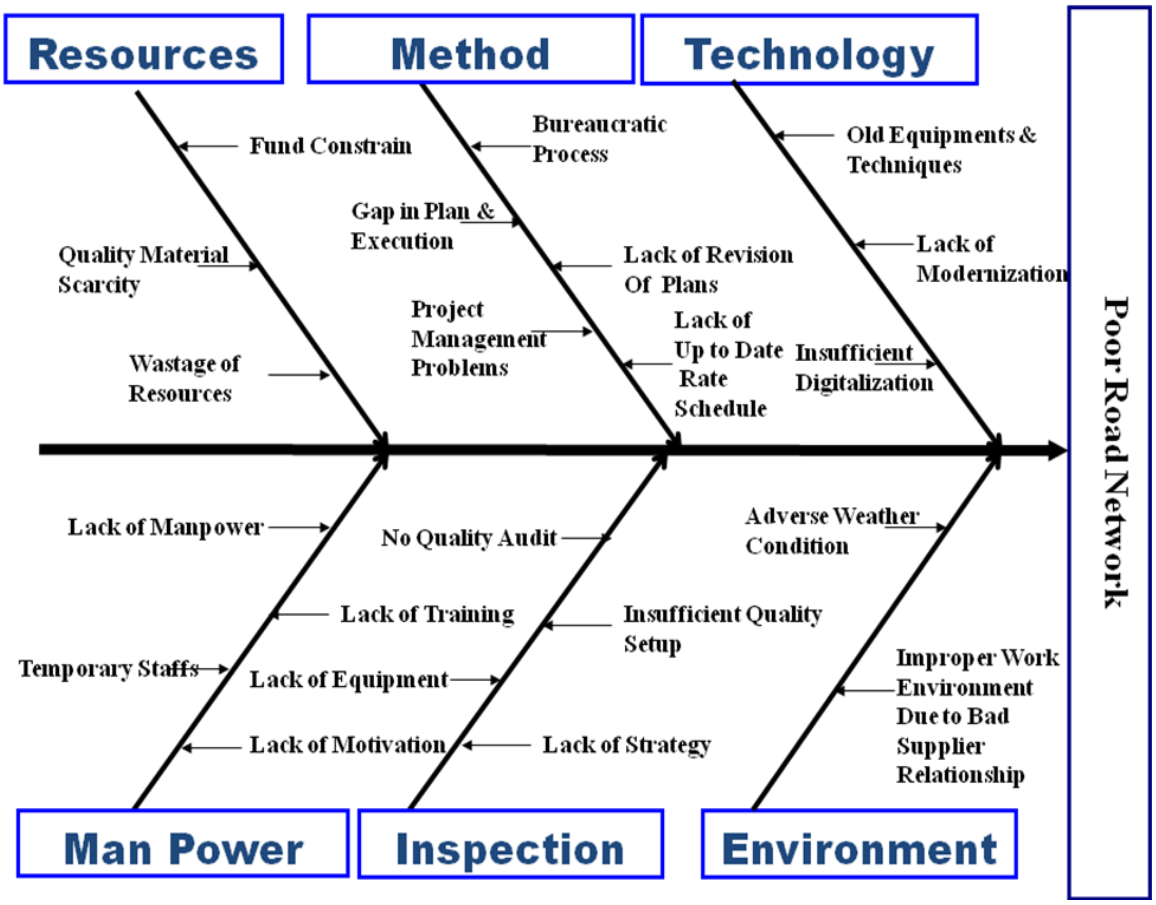

Figure 4-11: Cause Effect Diagram for Poor Road Network

Mentioned earlier RHD have a Quality Assurance Plan. It only deals with the quality in construction and have compatibility with other world standards. It comprises of proper flow charts for quality construction. But still there are quality problems; this is because of the lack of integration with other functions of the organization. So considering all the problems a Total Quality Management Plan for RHD should be developed.

DISCUSSION AND CONCLUSION

5.1 Discussion on Outcomes

It is obvious from chapter 3and 4 that certain things should be improved in RHD to overcome quality related problems. Currently in follows international standard and processes. RHD is concerned about quality and have both short and long term plan for quality road construction. But the problems related to quality lies in implementation. Implementations of plans are not followed properly. There are also issues in project management and contractor selection. The problems identified are not the only issues but if the identified issues can be solved than quality status of RHD will improve.

5.2 Recommendations

Followings are the recommendations of the study,

- The organizational structure should be expanded and the vacant posts should be filled in proper way.
- For quality testing of works the field labs should be established circle wise for the complex tests and at district level in every road division there must be provision of the simple testing. Specialized testing provision should be established in BRRL.
- Quality related training programs should be started.
- The suggestions of the Road Master Plan like axle load control should be implemented.
- Maintenance should be given priority. The total immediate maintenance of one year should be implemented to achieve value for money. The maintenance need can be covered from Road Maintenance Fund.
- To overcome financial constrains the projects should be implemented by Public Private Partnership, PPP.
- Despite low cost sourcing whole life costing should be considered. Item wise minimum coating limit should be imparted in PPR.

- Project Management should be strengthened and necessary actions should be taken to improve project management.
- For proper supplier selection should be selected instead of low cost supplier selection. The technical ability of contractor should be given priority.
- Land acquisition should be managed properly.
- Third party audit should be done by BRRL and it should also be given financial support.
- Improving the Quality Assurance Plan a Total Quality Management Plan should be developed. The TQM plan will increase quality in every aspect of RHD and quality road will be it sequential out come.

5.3 Conclusion

Some problems for quality degradation are identified in the study. For some problem the suggestions are given. But there are some problems which need further study as these issues have wide domain. But if the suggestion of the study is implemented properly the RHD will be able to provide safe, serviceable and cost effective road for the nation. The proper use of public money in road construction will help Bangladesh to become a medium income country of the world.

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